UNIVERSITY OF SCIENCE AND TECHNOLOGY MEGHALAYA

SYLLABUS

FOR

M.Sc. ENVIRONMENTAL SCIENCE

(CHOICE BASED CREDIT SYSTEM)

DEPARTMENT OF EARTH SCIENCE
SCHOOL OF APPLIED SCIENCES

UNIVERSITY OF SCIENCE AND TECHNOLOGY, MEGHALAYA

TECHNOCITY, KLING ROAD, 9TH MILE, BARIDUA, MEGHALAYA- 793101

M.SC. ENVIRONMENTAL SCIENCE
DEPARTMENT OF EARTH SCIENCE
SCHOOL OF APPLIED SCIENCES

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, Tezpur University and many national and international institutions.

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.

Course Offered & Duration:

Full time Post-Graduation (M.Sc.) course of two years duration divided into 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: 20 students

Preamble

Total No. of Semester	:	**04** (two Semesters per year)
Total Core paper	:	**15** (all semester)
Total Foundation Paper	:	**02** (semester I and II)
Total Elective Paper	:	**02** (semester III and IV)
Total Multidisciplinary Paper	:	**02** (semester III and IV)
Total No. of Papers	:	**21**
Total Credit	:	**88**
Internal Assessment per paper	:	**30** marks
End Semester per paper	:	**70** marks
Total marks per paper	:	**100** marks (excluding project work)
Total Marks for M.Sc. Degree		Theory Paper – **1700** marks
		Practical Paper – **300** marks
		Project work – **200** marks
Total Marks	:	**2200**

Examination Pattern:

I. The End Semester evaluation consists of 70% and the Internal Evaluation consists of 30% which includes 15% for sessional examinations, 9% for Assignments & Seminars and 6% for student's attendance, involvements and participants in various departmental activities.

II. The End Semester Question Paper consists of two parts:

Part A: Objective Question Type : **20** questions of 1 mark each. (all compulsory) = **1 X 20 = 20 marks**

Part B: Descriptive Question Type : **8** questions of 10 marks each (any five) = **10 X 5 = 50 marks**

III. Three sessional examinations of 30 marks in each paper are held every semester for internal evaluation along with one assignment & seminar from each theory paper.

1. **Course Content:**

SEMESTER	PAPER CODE	PAPER NAME
I	Core Course (CC I)	Fundamentals of Ecology
	Core Course (CC II)	Environmental Chemistry
	Core Course (CC III)	Environmental Pollution
	Foundation Course (FC I)	Computer Application and Information Technology
	Core Course (CC IV)	Laboratory I
II	Core Course (CC V)	Natural Resources and Biodiversity
	Core Course (CC VI)	Environmental Geosciences and Meteorology
	Core Course (CC VII)	Environmental Biotechnology
	Foundation Course (FC II)	Environmental Management and Sustainable Development
	Core Course (CC VIII)	Laboratory II
III	Core Course (CC IX)	Research Methodology
	Core Course (CC X)	Statistical Techniques
	Core Course (CC XI)	Geo-informatics
	Elective Course (EC I)	Environmental Impact Assessment (EIA)
	Core Course (CC XII)	Laboratory III
	Multidisciplinary Course (MDC I)	Northeast India: Land, People and Culture
IV	Core Course (CC XIII)	Environmental Education
	Core Course (CC XIV)	Occupational Hazards and Safety
	Elective Course (EC II)	Wildlife Ecology/Hazards and Disaster Management/Remote Sensing and GIS/Forest Ecology and Management/Environmental Monitoring
	Core Course (CC XV)	Dissertation
	Multidisciplinary Course (MDC II)	Disaster Management

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COURSE CODE: MEV **SCHOOL CODE: SOAS**

SEMESTER I

COURSE NO	TITLE	CREDIT	NATURE	MARKS ALLOTED		
				IA*	ES**	TOTAL
MEV 101	Fundamentals of Ecology	4	Theory	30	70	100
MEV 102	Environmental Chemistry	4	Theory	30	70	100
MEV 103	Environmental Pollution	4	Theory	30	70	100
MEV 104	Computer Application and Information Technology	4	Theory	30	70	100
MEV 105	Laboratory I	4	Practical	30	70	100
TOTAL		20		150	350	500

SEMESTER II

COURSE NO	TITLE	CREDIT	NATURE	MARKS ALLOTED		
				IA*	ES**	TOTAL
MEV 201	Natural Resources and Biodiversity	4	Theory	30	70	100
MEV 202	Environmental Geosciences and Meteorology	4	Theory	30	70	100
MEV 203	Environmental Biotechnology	4	Theory	30	70	100
MEV 204	Environmental Management and Sustainable Development	4	Theory	30	70	100
MEV 205	Laboratory II	4	Practical	30	70	100
TOTAL		20		150	350	500

SEMESTER III

COURSE NO	TITLE	CREDIT	NATURE	MARKS ALLOTED		
				IA*	ES**	TOTAL
MEV 301	Research Methodology	4	Theory	30	70	100
MEV 302	Statistical Techniques	4	Theory	30	70	100
MEV 302	Geoinformatics	4	Theory	30	70	100
MEV 304	Environmental Impact Assessment (EIA)	4	Theory	30	70	100
MEV 305	Laboratory III	4	Practical	30	70	100
MDC I	Northeast India: Land, People and Culture	4	Theory	30	70	100
TOTAL		24		180	420	600

SEMESTER IV

COURSE NO	TITLE	CREDIT	NATURE	MARKS ALLOTED		
				IA*	ES**	TOTAL
MEV 401	Environmental Education	4	Theory	30	70	100
MEV 402	Occupational Hazards and Safety	4	Theory	30	70	100
MEV 403	Elective Paper (any one)	4	Theory	30	70	100
(A)	Wildlife Ecology					
(B)	Hazards and Disaster Management					
(C)	Remote Sensing and Geographic Information System					
(D)	Forest Ecology and Management					
(E)	Environmental Monitoring					
MEV 404	Dissertation	8	Project	140	60	200
MDC II	Disaster Management	4	Theory	30	70	100
TOTAL		24		260	340	600

* IA – Internal Assessment
** ES – End Semester

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TOTAL MARKS: 500

SEMESTER I

MEV 101: Fundamentals of Ecology
MEV 102: Environmental Chemistry
MEV 103: Environmental Pollution
MEV 104: Computer Application and Information Technology
MEV 105: Laboratory I

MEV 101: Fundamentals of Ecology

Total Credit: 04

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.*

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 Ecology

Evolution Ecology: 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.

Essential Books:

1. *Fundamentals of Ecology* – E.P. Odum, Natraj Publishers, Dehradun.
2. *Ecology and Environment* – P.D. Sharma, Rastogi Publication.
3. *Concepts of Ecology* – E.J. Kormondy, Prentice-Hall of India Pvt. Ltd.
4. *Ecology and Field biology* – R.L. Smith, Harper Collins Publisher, New York.

Reference Books:

1. *Fundamentals of Ecology* – M.C. Dash, McGraw Hill Book Company.
2. *Ecology*: Individuals, Populations and Communities – Begon, Harper and Townsend, John Wiley & Sons.
3. *Organic Evolution* (revised Indianedn.) – R.S. Lull, Light & Life Publisher.
4. *Ecology: the Experimental Analysis of Distribution and Abundance* – Charles J. Krebs, Addison-Wesley Educational Publishers, Inc.

MEV 102: Environmental Chemistry

Total Credit: 04

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.*

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: Aquatic 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

Essential Books:

1. *Environmental Chemistry* – A.K. De, *Wiley Eastern Limited, 1990*
2. *Environmental Chemistry* – S.E. Mannhan, Lewis (1994).
3. *Methods in Environmental Analysis*: Water, Soil and Air, Agrobios – P.K. Gupta (2000)
4. *Basic concept of Environmental Chemistry* – D.W. Connel, Lewis (1997)

Reference Books:

1. *Environmental Chemistry* – G.S. Sodhi
2. *Environmental Chemistry* – Sharma and Kaur
3. *Environmental Chemistry* – Banerji
4. *Advanced Environmental Chemistry* – J.Sharma

MEV 103: Environmental Pollution

Total Credit: 04

Objective: *To understand the types, sources, effects, control measures and treatment processes of different types of environmental pollution and also to know about the environment related laws and acts of India.*

UNIT I: Air Pollution

Types and sources of air pollution; Primary and secondary pollutants; determinants of air pollutants; Transports and diffusion of pollutants. Criteria air pollutants. Methods of monitoring and control of air pollution, O_3 layer depletion, acid rain, Effects of pollutants on human beings, plants, animals, materials and on climate. Air quality standards. Trans-boundary air pollution; Acid Rain; Implication of air pollutants; 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.

UNIT IV: Noise Pollution

Sources of noise pollution, measurement of noise pollution, noise exposure levels, effect of noise pollution, Noise control and abatement measures, Sources and effects of radioactive pollution, Thermal Pollution.

Essential Books:

1. *An Introduction to Air Pollution – R.K. Trivedi, DVS Publication (2003)*
2. *Inorganic Contaminants of Surface Water –W.Moore James, Springer-Verlag*
3. *Methods of Air Sampling and Analysis – J.P. Lodge Jr. (edtr.), Lewis (1998)*
4. *Air Pollution and Control* – K.V.S.G. Murlikrishan
5. *Industrial Noise Pollution* – Bell and Bell

Reference Books:

1. *Environmental Pollution and Health Hazards* – A. Kumar and M.C. Varma
2. *Fundamentals of Ecology* – M.C. Dash
3. *Environmental Engineering* – N.N. Basak
4. *Climatology*: An Atmospheric Science – J.E. Oliver and J.J. Hidere

MEV104: Computer Application and Information Technology

Total Credit: 04

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

Unit I: Computer Systems and Information Technology
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 II: 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.

Unit II: Data processing
Data, Information and Knowledge, Data Processing Functions and Modes, Processing Applications, Records, Files, File Organizations, File Operations, File Processing, Activities, Reporting.

Unit IV: Computer Application and Information Technology in Earth Science studies
Applications in the field of Wildlife and Forestry, Disaster Management, Pollution Monitoring, LULC and Wetland mapping, Agriculture, Groundwater management, Coastal and Marine application, Industry and mining modelling, Soil survey, Desertification, Impact Assessment, overall changes in global environmental scenario.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:
1. *Fundamentals of Computers* – V. Rajaraman, Prentice Hall of India, New Delhi.
2. *Fundamentals of Information Technology* – Deepak Bharihoke, Excel Books.
3. *A first course in computer*– S. Saxena, Vikas Publishing House Pvt. Ltd.
4. *Basic Computer Course Book* – P. Colleti, (8^{th} Edition) Bolzano Bozen.

Reference Books:
1. *Foundations of computing* – P.K. Sinha& P. Sinha (2002),Bpb, Publication.
2. *Operating Systems* – William Stalins, Pearson Higher Education.
3. DOEACC Basis Level Course books

MEV105: Laboratory I

Total Credit: 04

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

- **Practicals on MEV 101:**

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 MEV 102 and MEV 103:**

1. Study of pH of soil.
2. Study of soil bulk density and porosity.
3. Study of soil texture.
4. Estimation of soil organic carbon.
5. Study of pH of water.
6. Measurement of turbidity in aquatic ecosystem by Secchi disc.
7. Estimation of free CO_2 in different water samples.
8. Analysis of water and effluent - Physical parameters, Chemical parameters, Nutrient parameters and Bacterial parameters.
9. Colorimetric experiments - Estimation of $Fe2^+$, $Fe3^+$ and $Ni2^+$
10. Study of level of noise pollution.
11. Identification of solid waste material inside the university campus.
12. Local Field visit.

- **Practicals on MEV 104:**

1. Hands on practice on basic computer tools (specially MS Office tool)
2. To understand practicalities of various software packages.

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SEMESTER II

MEV 201: Natural Resources and Biodiversity
MEV 202: Environmental Geosciences and Meteorology
MEV 203: Environmental Biotechnology
MEV 204: Environmental Management and Sustainable Development
MEV 205: Laboratory II

MEV 201: Natural Resources and Biodiversity

Total Credit: 04

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.*

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, problems & threats and management system; role of WWF, WCU, CITES, TRAFFIC; Eco-tourism.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:

1. *Biodiversity*: *an introduction*- Gaston, K.G. (2004) (2nd edition). Blackwell Science Ltd.
2. *Biodiversity: monitoring, management, conservation and enhancement.* Geethabali, R.R.(2002). APH Publishing, New Delhi.
3. M *Biodiversity concept,* conservation and bioculture. F.B. Mandal and N.C. Nandi (2009), Asian Books Ptd. Ltd.

Reference Books:

1. *The Forest Types of India* – Champion and Seth
2. *Ecology of Natural Resource* – Ramade
3. *Global Biodiversity* – W.R.L. IUCN
4. *Natural Resource Conservation* – Owen and Chiras

MEV 202: Environmental Geosciences and Meteorology

Total Credit: 04

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

UNIT I: General Geomorphology and Geohydrology

Origin and Evolution of earth; Plate tectonics, sea floor spreading, continental drift and mountain building; Weathering of rocks-; 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, forest hydrology, hydrological forecasting, watershed management.

UNIT II: Geological activities and hazards

Concept of stress and strain; Mechanism and classification of folds and faults; Recognition and genesis of minor structural elements- foliation, lineation, drag folds, cleavage and joints. Types of rocks; Formation and classification of mineral deposits; Environmental problems associated with extraction of minerals.

Geological hazards: Mechanism- causes, nature, frequency, effects, prediction, perception & adjustments to natural hazards (earthquake, flood, volcanism, landslides, fire, erosion & cyclone.)

UNIT III: Meteorology

Meteorology fundamentals, atmospheric stability diagrams, turbulence, diffusion. Thermal structure of the atmosphere and its composition, earth and sun relations - rotation, revolution and seasons radiation from sun, solar constant, effects of cloud, surface and planetary albedo, emission and absorption of terrestrial radiation, radiation windows, net radiation budget, thermodynamics of dry and moist air, adiabatic and isoentropic processes, moisture variables, virtual temperature, adiabatic processes of moist air, thermodynamic diagrams, dry and moist air parcel.

UNIT IV: Climatology

Elements of climate, climate controls, Earth's radiation balance, latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance, spatial and temporal patterns of climate parameters, Air masses and fronts; World Climate Types, El-Nino and La-Nina; Indian Monsoon, spatial and temporal patterns of climatic parameters - temperature, rainfall and its variability in India with special reference to NE India; causes and effects of climate change.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:

1. *Atmosphere, Weather and Climate* – G.G. Barry and Chorley, Methuen and Co.,London.
2. *Elementary hydrology* (1994): V. P. Singh, Prentice-Hall of India.
3. *Hydrology: Principles, analysis and design* (1996) – H. M. Raghunath, New Age International Publisher
4. *An introduction to the environmental physics of soil, water and watersheds* (2004) – C. Rose, Cambridge University Press
5. *Geology of India* – D. N. Wadia, MacMilanPulb.

Reference Books:

1. *General Climatology* – H.F. Critchfield,PrenticeHall of India Pvt. Ltd., New Delhi.
2. *Applied Climatology* – J.E. Hobbs, Oxford University Press.
3. *Himalayan Snow and Glaciers*: Bahadur; Concept Pulb.
4. *Climatology* – D.S Lal, ShardaPustakBhawan, Allahabad

MEV 203: Environmental Biotechnology

Total Credit: 04

Objective: *To understand the development of biotechnology and microbiology and its application in the field of environmental science for further in-depth study and proper management which have less environmental harmful effects.*

UNIT I: Introduction to Environmental Biotechnology

Definition and scope of Environmental Biotechnology: Microbial process involvement in biocomposting, biofertilizers, biopesticides, and bio-weedicides. Bioplastic and biosensors for environmental monitoring.Microbes in normal (soil, water and soil) and extreme (thermophiles, acidophiles, psycrophiles, halophiles and xerophiles) environment. Methanogens and their applications. Biochemical process of methanogenesis.

UNIT II: Microbial waste treatment processes

Involvement of microbes in domestic and industrial waste-water treatment: Solid Waste Management: Sources and types of solid waste, methods of disposal of solid waste (incineration, composting and sanitary landfill), Liquid Waste Management: Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic–oxidation pond, trickling filter, rotating biological contractor/ biodisc system, activated sludge process and anaerobic–septic tank, imhoff tank, anaerobic digester) and tertiary sewage treatment. Bioleaching: Concept and application of microbes in bioleaching of copper and gold. Microbial enhanced oil recovery (MEOR) technique.

UNIT III: Bioremediation

Bioremediation: Concept (*in situ* and *ex situ* bioremediation) and role of bioremediation in controlling various pollution problems (industrial and medical effluents,). Basic concept of phyto-remediation and myco-remediation. Bioremediation of heavy metals, oil spills, plastics, cellulose and paper, xenobiotics. Radioactive waste: Sources, half-life of radioactive elements and mode of decay.

UNIT IV: Biofuels and Environmental genomics

Biofuels: Role of microbes in hydrogen gas and fuel alcohol production. Biopolymers, SCP and enzyme production and their applications, Vermicomposting and Fermentation Technology (Bioreactors), Biotechnological strategies for forestry & wasteland management.

Environmental genomics/ metagenomics: a general account. Environmental bio-safety: a general account. Dielectrophoresis and its environmental applications. Culture dependant and culture independent techniques in Environmental Biotechnology: ARDRA, DGGE, FAME profile analysis, G+C analysis.

Note: Seminar and Group discussion may be incorporated during class hour.

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. *Genetically Modified Organisms in Agriculture: Economics and Politics* – G.C. Nelson (2001).Academic Press.
4. *Environmental Biotechnology: Theory and Application* – G.M. Evans and J.C. Furlong(2003).John Wiley and Sons.
5. *Biotechnology and Safety Assessment* – J.A. Thomas and R. Fuchs (2002)Academic Press.

Reference Books:

1. *Advanced Physicochemical Treatment Processes* – L.K. Wang L.K, Y.T. Hung and N.K. Shammas (Eds.) 2006, Springer-Verlag, New York, LLC.
2. *Biotechnological methods of Pollution control* – S.A. Abbasi, and E. Ramasami (1999), University Press, Hyderabad.
3. *Environmental Biotechnology* – Alan Scrogg (2005) (II ed.), Oxford University Press, New York.
4. *Environmental Microbiology* – P.K. Jemba (2004), Science Publishers, USA.
5. *Environmental Science and Biotechnology* – A.G. Murugesan and C. Rajakumari (2006),MJP Publishers, Chennai.

MEV 204: Environmental Management and Sustainable Development

Total Credit: 04

Objective: *To provide the knowledge and mechanism of sustainability and its utilization in various fields of environmental management.*

UNIT I: Introduction to Environmental Management

Concept of environmental management, Environmental Management of industries and mines, Environmental Planning; Environmental auditing, management system and accounting for eco-efficiency; Ecomark; ISO certification; Environmental clearance.

UNIT II: Risk assessment and waste management

Risk assessment- human health risk assessment, ecological risk assessment, probalistics risk management; the role of risk assessment in Environmental Management decisions; Risk management and Risk communication.

Solid wastes management: source, characteristics, chemical composition, different methods of disposal and management of solid wastes (hospital and hazardous wastes), Waste minimization technology, Hazardous wastes management and handling rules; No fault liability.

UNIT III: Land use planning

Land use planning; land use plan in India; Soil survey in land use planning; Urban and Rural planning for India; Ecosystem and social processes in Rehabilitation of a) degraded rural landscape, b) unbalanced soil, c) specialized habitats, d) mining areas.

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.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:

1. *Environmental planning, policies and programs in India* – K.D. Saxena.
2. *A Practical Guide to Understanding Management and Reviewing Environmental Risk Assessment Reports* – Sally L. Benjamin and David, A. Bullock, (2001) Lewis Publishers, Washington D.C.
3. *Hand Book of Environmental Risk Assessment and Management:* Peter Calow (1998), Blackwell-Synergy, London.
4. *Environmental Management in Practice,Volume – I to III Instruments for Environmental Management* – B. Nath, L. Hens, P. Compton and D. Devuyst (1998), Routledge, London and New York.
5. *Risk based analysis for Environmental Managers* – A. Kart and Frantzen, (2001) Lewis Publishers, Washington D.C.
6. *Risk Assessment in Environmental Management* – D. Kofi Asante, Duah, John Willey and Sons, New York.

MEV 205: Laboratory II

Total Credit: 04

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.*

- **Practicals on MEV 201:**

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 MEV 202:**

1. Study of tools and techniques used for meteorological studies.

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 MEV 203:**

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 andSons.
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. Shammas (Eds.) 2006, Springer-Verlag, New York, LLC.

- **Field visit.**

TOTAL MARKS: 600

SEMESTER III

MEV 301: Research Methodology
MEV 302: Statistical Techniques
MEV 303: Geoinformatics
MEV 304: Environmental Impact Assessment (EIA)
MEV 305: Laboratory III
MDC I : Northeast India: land, People and Culture

MEV 301: Research Methodology

Total Credit: 04

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.*

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 & difficulties.

UNIT II: Sampling
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 schedule &data analysis.

UNIT III: Data processing and analysis
Project formulation& Report writing, Research problem, survey of literature, research methods applied, SPSS, content analysis, conclusions, Quotations, Footnotes, References and Bibliography.

UNIT IV: Research process
Moral and Ethical questions in Scientific writing, outline, structure & screening of the article/manuscript, Description, value and development of points/outlines before writing, Importance of Authors and theirsequence, importance of clear title, abstract or summary, Introduction, Methods and Methodology, Results and Discussion. Numbers and statistics, Tables and Figures, Writing Style: Active or passive, Punctuation, use of commas, apostrophe, semicolon and colon. Avoiding duplication and repetition; Importance of revisions and references; Plagiarism, paraphrasing and copyright violation

Assignment & Seminar:
Formulation of a research proposal on a topic related to subject.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:

1. *Writing Your Thesis*(2nd Edition) Paul Oliver, New Delhi: Sage.
2. *Research Methods in the Social Sciences* – Bridget Somekh and Cathy Lewin, Vistaar, New Delhi.
3. *Research Methodogy: Methods and Techniques* – C.R. Kothari, New Age International (P) Limited, Publishers, New Delhi.
4. *Research Methodology* – Ram Ahuja, RawatPulb. Jaipur.

Reference Books:

1. *Statistics for biology*: The Foundations of Behavioral Research – F.A. Kerlinger Orland: Harcourt Brass, Longman, London.
2. *Methods In Social Research* – Wililam J. Goode and Paul H.Hatt, Indian Edition, McGraw Hill, New Delhi.
3. *Survey Methods in Social Investigation* – Sir Claus Moser and GrhamKalton,Dartmouth, New York.
4. *Social Research, Strategy and Tactics* –Bernard S.Philips, Macmillan, New York

MEV 302: Statistical Techniques

Total Credit: 04

Objective: *The main objective of this paper is to give the quantitative and qualitative processing and analysis of data for quality research work.*

UNIT I: Basic Statistics

General concepts and significance of statistics to applied sciences, Variables - Discrete and continuous; Data collection - primary and secondary; Tabulation and graphical representation of data- line diagrams, bar diagrams, histograms, frequency polygon, pie chat and pie diagram, Frequency distribution.

UNIT II: Descriptive Statistics

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 III: Correlation and Regression analysis

Concept of correlation and their types; Properties of- simple (linear), partial and multiple correlation ; Coefficient of correlation and their properties; Concept of regression, Properties of- simple (linear), partial and multiple regression, Coefficient of regression and their properties, Fitting of regression line; Multiple and partial correlations and regressions.

UNIT IV: Factor analysis and Statistical Inference - Hypothesis Testing

Cluster analysis, Types- hierarchical clustering, Centroid-based clustering, Distribution-based clustering, Density-based clustering, Principal Component Analysis (PCA). Probability theory, Hypothesis; null hypothesis; Types of error, Test of hypotheses- chi square test, T-test, Z-test, F-test and Analysis of variance-one way-ANOVA, Two way ANOVA; Statistical software-SPSS, STASTICA etc.

Note: Seminar and Group discussion may be incorporated during class hour.

Essential Books:

1. Ram Ahuja, *Research Methods*, Rawat Publication, New Delhi.
2. Birdie, Douglas and Anderson, *Questionnaires Design and Use*, The Scarecrow Press, Inc.
3. C.R. Kothari, 2004, *Research Methodogy Methods and Techniques*, New Age International (P) Limited, Publishers, New Delhi.
4. Payne, Stanley, *The Art of Asking Question*, Princeton, Princeton University Press.
5. *Statistical Methods*, Gupta and Gupta (2005), Sultan Chand and Sons.

MEV 303: Geoinformatics

Total Credit: 04

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.*

UNIT I: Remote Sensing

Remote sensing: Definition, history & Concepts; Electromagnetic spectrum and Spectral reflectance; Types of Remote sensing and resolution; Remote sensing satellites: Indian and other countries (LANDSAT, IRS, IKONOS, QUICK BIRD, CARTOSAT, etc.). Aerial photography and Visual image interpretation: Types, Scale and Geometry; Elements of image interpretation and interpretation keys.

UNIT II: Digital Image Processing.

An introduction to Digital Image Processing (DIP) Systems; DIP Techniques: Image enhancements; Supervised and Unsupervised classification, Accuracy assessment.

UNIT III: Geographical Information System

GIS: Introduction, Principles and concept; GIS components and softwares; Spatial and non-spatial data; Raster and Vector data structure and conversion; Georeferencing: coordinate and projection system; datum concept; Map design, layout and output.

UNIT IV: Global Positing System and Global Navigation Satellite System

GPS- Definition, history and fundamentals. Types of GPS; Accuracy of GPS, GPS Signal, Errors in Signals; Navigation system – GNSS, GLONASS, Galileo, IRNSS; Surveying techniques with GPS, Applications of GPS; concept and principles of DGPS; Applications of DGPS.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

1. *Introduction to Remote sensing* – G. Joseph, Universities Press.
2. *Handbook of Aerial photography and Interpretation* – K.K. Rampal, Concept Pulb. Comp., New Delhi.
3. *Introduction to Geographic Information System* – Kang-tsung Chang (4th Ed.), Tata McGraw-Hill.
1. *Essentials of GPS* (2004): N. K. Agarwal, Spatial Networks Pvt. Ltd., Hyderabad.
4. *Introductory Digital Image Processing: A Remote Sensing Perspective* – Jensen, J.R., (New Jersey: Prentice-Hall).
5. *Remote sensing and Image Interpretation* – Lillesand, Kiefer and Chipman (6th Ed.), Wiley.

MEV 304: Environmental Impact Assessment (EIA)

Total Credit: 04

Objective: *To understand the fundamentals of EIA and different techniques and tools, this can appropriately be utilize for environmental planning and various studies.*

UNIT I: Environmental Impact Assessment

Introduction To EIA**:** Purpose of EIA; Environmental components, principles of EIA, Concept and approaches of EIA, Historical development of Impact Assessment process, methods and procedure and current issues in EIA.

UNIT II: Impact Assessment Procedure

Projects screening and scoping; Environmental baseline study. Applications of Matrices; Networks and Overlay maps; Environmental evaluation system; Impact identification; Impact prediction; Evaluation and mitigation; Monitoring and Environmental auditing; Environmental management plan; Cost benefit analysis and its dimensions; Problems of EIA in developing countries; Public participation in environmental decision making, presentation and review; EIA report and its contents.

UNIT III: National Procedures of EIA

Development of EIA process in India; comparison between Indian EIA procedure with few developing and developed countries; some important case studies of EIA.

UNIT IV: EIA Regulations and policies in India

Environmentlal Action Programme, National Environmental Policy Act, Legislative framework- Water prevention and control of pollution Act, Air prevention and control of pollution Act, Atomic Energy Act, Motor vehicles Act, Wildlife protection Act, The forest conservation Act, Public liability Insurance Act; National Environmental Tribunal Act, 1995.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

1. *Introduction to Environmental Impact Assessment (2nd Ed.)* – J. Glasson, R.Therivel and A. Chadwick, UCL Press, Philadelphia, USA, 1994.
2. *Environmental Impact Assessment*(2nd Ed.) L.W. Canter, McGraw Hill, New York, 1996.
3. *Environmental Impact Assessment: A methodological perspective* – R.K. Morgan, Kluwar Academic Publications, Boston, 1998.
4. *Environmental Impact Analysis Handbook*: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.

Reference Books:

1. *Methods of Environmental Impact Assessment*: P. Morris & R. Therivel; UCL Press
2. *Environmental Impact Assessment (2003)*: A. K. Srivastav; APH Publishing Corporation
3. *Introduction to Environmental Impact Assessment*: Glasson; Research Press

MEV 305: Laboratory III

Total Credit: 04

- **Practicals on MEV 303:**

1. Geometry of aerial photographs and satellite images.
2. Image interpretation and feature identification based on interpretation keys.
3. Scanning and digitization of maps of different themes and layer creation.
4. Geo-referencing of scanned maps and satellite images; mosaicking and layering of images.
5. Computer application in drawing of cartograms: Bar graph, Pie -graph, Histogram and Scatter diagram
6. Editing attribute tables using data related to Indian climate.
7. Image enhancements and Classification- Supervised and Unsupervised.
8. GPS/DGPS data collection and mapping.

Essential Books:

1. *Introduction to Remote sensing* – G. Joseph, Universities Press.
2. *Handbook of Aerial photography and Interpretation* – K.K. Rampal, Concept Pulb. Comp., New Delhi.
3. *Introduction to Geographic Information System* – Kang-tsung Chang (4th Ed.), Tata McGraw-Hill.
2. *Essentials of GPS* (2004): N. K. Agarwal, Spatial Networks Pvt. Ltd., Hyderabad.
4. *Introductory Digital Image Processing: A Remote Sensing Perspective* – Jensen, J.R., (New Jersey: Prentice-Hall).
5. *Remote sensing and Image Interpretation* – Lillesand, Kiefer and Chipman (6th Ed.), Wiley.

MDC I: Northeast India: Land, People and Culture

Total Credit: 04

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

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.

References:

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;
5. Shafi, M: Geography of South Asia, McMillan & Co., Calcutta, 2000.
6. Discovery of North East India - Geography, History, Culture, Religion, Politics, Sociology, Science, Education and Economy (11 Volumes) Mittal Publications.
7. Dikshit, K. R.*et.al.*:North-East India: Land, People and Economy, Advances in Asian Human-Environmental Research, Springer Science+ Business Median Dordrecht 2014.

TOTAL MARKS: 600

SEMESTER IV

MEV 401: Environmental Education

MEV 402: Occupational Hazards and Safety

MEV 403: Elective paper (any one)

- **(A): Wildlife Ecology**
- **(B): Hazards and Disaster Management**
- **(C): Remote Sensing and Geographic Information System**
- **(D): Forest Ecology and Management**
- **(E): Environmental Monitoring**

MEV 404: Dissertation

MDC II : Disaster Management

MEV 401: ENVIRONMENTAL EDUCATION

Total Credit: 04

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

UNIT I: Introduction to Environmental Education

Environmental education: Goals and objectives of environmental education; components of environmental education; environmental education in India; value education; objectives, environmental values, valuing nature and cultures.

UNIT II: Environmental awareness and movements

Environment 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; case studies: national and local.

UNIT III: Environmental ethics

Environmental ethics: Definition, history, scope and basic concepts; anthropocentrism, biocentrism and ecocentrism; deep ecology; ecofeminism; ecocentrism in indigenous societies and culture; ethics of pollution by xenobiotics; ethics of global climate change; ethics of pesticide use.

UNIT V: Global issues of environmental awareness

Current Environmental issues and problems at global, regional and local levels, Climate change, Global warming, Population explosion, Resettlement and Rehabilitation of people, agriculture system like shifting cultivation, role of environmental education, IT & media in the management and conservation of environment, Human society and environment.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

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

Reference Books:

1. *Ecological thought:an introduction:* I.M. Hayward, Polity press, Cambridge.
2. *Text book of environmental studies:* E. Bharucha,UniversityPress,Hyderabad.
3. *Ecology (Key concepts in critical theory)*: C. Merchant, Rawat Publications, Jaipur.
4. *Environmental studies*: M. Tiwari, K.Khulbe and A. Tiwari, I.K.International, New Delhi.

MEV 402: Occupational Hazards and Safety

Total Credit: 04

Objective: *To understand the development of human service for global industrialization and modernization and its impact on human health and overall environment.*

UNIT I: Introduction to environmental health

Environmental Health: Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health.

UNIT II: Workplace and Health hazards

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents; Environmental Diseases: Asbestosis, Silicosis, Sinicizes, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kalaazar; case studies: international, national and local.

UNIT III: Occupational Safety

Occupational Safety and Health: The relationship of occupational hygiene/safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

UNIT IV: Exotoxicology

Ecotoxicology: types, sources and effects; Transport of toxicants by air and water; Transport through food chain - bio-transformation and bio-magnification; Routes of toxicants to human body; Response to toxin exposures: Dose response, Frequency response and cumulative response; Lethal and sub-lethal doses; Dose- Response relationships between chemical and biological reactions; Detoxification in human body - detoxification mechanisms, organs of detoxification.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

1. *Basic Environmental Health* (2001): AnnaleeYassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti
2. *Environmental pollution and its management* – P. Shrivastava, (2000), APH Publishing
3. Corporation, New Delhi. *Handbook of Environmental Health and Safety – principle and practices* : H. Koren; Lewis Publishers
4. *Principles of Environmental Toxicology*: I. C. Shaw and J. Chadwick; Taylor& Francis ltd.

MEV 403 (A): Wildlife Ecology

Total Credit: 04

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.*

Unit I: Wildlife of India with reference to NE India

Characteristic, composition and distribution of terrestrial ecosystem (with special reference to grassland and forest ecosystems of N E India)**;** Wetlands of NE India as wildlife habitat; Wildlife zones in India; Habitat assessment indices- community dominance index (CDI), canopy area coverage, foliage height diversity (FHD); Concept of key stone and umbrella species; Feeding and social behavior; Social organization in mammals.

Unit II: Wildlife migration and census techniques

Migratory birds and migratory routes of birds in Indian subcontinent; Amphibian and reptilian fauna of India; Conservation issues of herpeto-fauna in India; Case studies of some important wildlife of India with special reference to N. E. India. Techniques of wildlife census; Habitat utilization pattern of rhino, hoolock gibbon, tiger, elephant and their management techniques;

Unit III: Wildlife conservation and management strategies

Threats and values of wildlife; Endangered and threatened plants & animals of India and NE India; *In-situ*, *Ex-situ* and community conservation systems; Conservation needs- breeding and importance of genetics in wildlife conservation; role of zoos, parks, gardens and aquariums in conservation of wildlife; ethics of wildlife conservation; Case studies of different wildlife projects in India; Principles and strategies of wildlife management in protected areas (sanctuaries, national park, biosphere reserves etc.); Role of government and non-governmental organizations (International, national & regional) in wildlife management and conservation; Wildlife Act.

Unit IV: Wildlife economy and trade

Contribution of wildlife to gross national productivity (GNP) and economic importance of wildlife; wildlife tourism; trade on wildlife and wildlife crime; wildlife corridors; developmental activities versus wildlife conservation; man –animal conflicts; Impact of climate change on wildlife.

Note: Seminar and Group Discussion may be incorporated during class hour.

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

Reference 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

Total Credit: 04

Objectives: *To provide depth 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

Disasters: Definition, Hazard, Risk, Vulnerability, Mitigation. 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)*, Disaster Management Cycle.

UNIT II: Environmental and Human Induced Disasters

Environmental disasters –Earthquake and associated impacts, Earthquake prediction, Structural damage and its prevention, Dams and earthquakes, Tsunami: Mechanism and Control; Coastal Disaster and management (CRZ); Flood and Drought – causes, impacts, precautions and mitigation, Landslide and River bank Erosion – Mechanism and Control.Human induced disasters –Industrial and chemical disasters, road/air/rail accidents, fire incidents, epidemics, disease outbreaks, alcoholism and suicides, violence, occupational health hazards, poverty, urban slum, migration and refugees, conflict, terrorism. Adaptation Strategies.

UNIT III: Trends in Disaster Management and Disaster Mitigation

Traditionl and modern conceptualisation of Disaster, Folk paradigms in Disasters. Progress in the International Decade for Natural Disaster Reduction (IDNDR), Hyogo framework, Disaster prevention through Sustainable development and community participation.

Concept of mitigation and preparedness, Institutional framework for disaster preparedness and mitigation- Global and Indian scenario, Training Need Analysis and Human Resource Development Plan, Inter-development Corporation for Disaster Mitigation. Coordination(with Civil Authorities including Community, NGOs representatives and other organizations), Planning and Networking Concept of Trigger Mechanism, ICT in Disaster Mitigation, Applications of GIS and GPS 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.

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.

Reference 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.

MEV 403 (C): Remote Sensing and Geographic Information System

Total Credit: 04

Objective: *To provide thorough knowledge on space science technology and its application on various fields of environmental study and research.*

UNIT I: Remote Sensing Techniques

Principles of remote sensing, Spectral reflectance based on characteristics of earth surface (rocks, soils, vegetation, water); principle of photogrammetry and stereophotography; Principles of Thermal, Hyper spectral and Microwave remote sensing.

UNIT II: Advance Image Processing

Digital Image Processing: Image segmentation, Advance classification methods, Image enhancement techniques, accuracy assessment; Digital change detection.

UNIT III: Advance GIS Techniques

Spatial data, Topology creation, Overlay analysis. Spatial interpolation techniques - types, uses and problems Digital elevation/terrain model; Triangulated Irregular Networks (TIN); Watershed analysis; Network Analysis; Web-GIS; Errors in GIS. Concept-Datum, geoid, Geographic coordinate system; Fundamentals of geodesy, geodynamics, geomatics, cartography.

UNIT IV: Application of Remote Sensing and Geographic Information System

Applications of GIS & RS: Wildlife and Forestry, Disaster Management, Pollution Monitoring, LULC and Wetland mapping, Hill Ecology and management, Agriculture, Groundwater management, Coastal and Marine application, Industry and mining modelling, Soil survey, Desertification, Impact Assessment, overall changes in Global scenario.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

1. *Remote sensing & Image interpretation* – Lillesand Thomas M, &Keifer
2. *Introductory Digital Image Processing: A Remote Sensing Perspective* – Jensen, J.R., (New Jersey: Prentice-Hall).
3. *Geographic Information Systems*: Martin, Routledge
4. *An Introduction to GIS*: Heywood, Pearson
5. *Essentials of GPS* (2004): N. K. Agarwal, Spatial Networks Pvt. Ltd., Hyderabad.

Reference Books:

1. *Remote Sensing of the Environment: An Earth Resource Perspective* – Jensen, J.R., (2004):, Pearson Education
2. *Remote sensing and Image Interpretation* – Lillesand, Kiefer and Chipman (6th Ed.), Wiley.
3. *Introduction to Geographic Information System* – Kang-tsung Chang (4th Ed.), Tata McGraw-Hill.
4. *Introduction to Remote sensing* – G. Joseph, Universities Press.
5. *Handbook of Aerial photography and Interpretation* – K.K. Rampal, Concept Pulb. Comp., New Delhi.

MEV 403 (D): Forest Ecology and Management

Total Credit: 04

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

Unit I: Forest Ecosystem

Forest and Forestry: Definition of forest and forestry, branches of forestry and their relationships, Influence of forests on environment. Structure of forest ecosystem; Role played by light, temperature, rainfall, snow, wind, humidity and evapo-transpiration in forest ecosystem, Bioclimate and micro climate effects. Major forest types of the world; Forest types and forest cover of India with special reference to North East India.

Unit II: Forest Regeneration

Forest reproduction: flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration.Natural regeneration - seed production, seed dispersal, germination and establishment.Requirement for natural regeneration.

Unit III: Forest Productivity

Forest ecosystem function: Productivity of forest ecosystems; Patterns of primary productivity in forest ecosystems; Phenology, Litter production and decomposition; Nutrient cycling and nutrient conservation strategies; Forest hydrology; Forest fire; Carbon sequestration in forest vegetation.

Unit IV: Forest Management and policies

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; Agroforestry system in India with case studies of NE India. Forest laws and economy: Forest laws and acts in India; Non Timber Forest Products (NTFPs) and Silviculture; Forest trade; Forest diseases and control measures; Forestry and tourism.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential books:

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

Reference Books:

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

MEV 403 (E): Environmental Monitoring

Total Credit: 04

Objective: *To provide depth knowledge on tools and techniques of environmental monitoring of air and water pollutions, toxic & hazardous substances, and their control & management*

UNIT I: Introduction to Environmental Monitoring

Monitoring of air and water pollution: Biomonitoring of air pollution-plants as biomonitors; biomonitoring of running water pollution-saprobic, diversity and biotic approaches; biomonitoring and bioaccumulation of heavy metals in aquatic ecosystems; bioaccumulation of pesticides in aquatic ecosystems; Bioindicators.

UNIT II: Environmental toxicology

Aquatic toxicology**:** Acute toxicity; sublethal, chronic toxicity; multispecies toxicity tests; microorganisms in toxicity testing: microtox and other approaches.

Emerging areas**:** Basic concepts of toxicogenomics; toxicity of engineered nanoparticles; endocrine disrupting chemicals and their hazards; risk assessment of electromagnetic radiation.

UNIT III: Instrumentation and Application

Instrumentation and Application: Colorimetry and Spectrophotometry- Atomic Absorption Spectrometry, Flame Emission Spectrometry and Inductively Coupled Plasma Mass Emission Spectrometry; Chromatography- Thin layer chromatography, ion exchange chromatography, Gas Chromatography and High Performance Liquid Chromatography.

UNIT IV: Development 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 and Biosensors for environmental monitoring.

Note: Seminar and Group Discussion may be incorporated during class hour.

Essential Books:

1. *Heavy metals in the environment.* S.A. Abbasi, N. Abbasi, and R.Soni, (1998), Mittal Publications, New Delhi.
2. *Wastewater microbiology* (2^{nd} edition): Bitton, G. (1999),Johm Wiley and Sons.
3. *Ecotoxicology: A comprehensive treatment*. M.C. Newman and W.H. Clements, (2008). CRC Press.
4. *Biomedical waste management*. R. Radhakrishnan (2002), Sumit Enterprises, New Delhi.
5. *Monitoring ecological change*. I.F. Spellerberg (1995), Cambridge University Press.

Reference Books:

1. *Environmental monitoring*. G.B. Wiersma (Ed.) (2004), CRC Press.
2. *Ecotoxicology: ecological dimensions*. Baird, Maltby, Greig-Smith and Douben (Eds.). (1996). Chapman and Hall.
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 Publishers.

MEV 404: Dissertation

Total Credit: 08

A project work on elective paper (any one from MEV 404 – A/B/C/D/E) is to be carried out during final semester and the project report should be submitted on the day of presentation and viva-voce at the end of the End Semester (4^{th} semester) examination. The project report carries a total of 8 credits (equivalent to 200 marks) which include the quality and extent of work along with viva-voce. The report has to be submitted in the form of Dissertation or Thesis.
The assessment of marks includes following parameters:

- Contents in the dissertation.
- Fulfilment of objectives.
- Depth of study.
- Quality of work.
- Regularity and sincerity in work.
- Submission and Presentation.
- Viva-voce.

MDC II: Disaster Management

Total Credit: 04

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

Environmental disasters –Earthquake and associated impacts, Earthquake prediction, Structural damage and its prevention, Dams and earthquakes, Tsunami: Mechanism and Control; Coastal Disaster and management (CRZ); Flood and Drought – causes, impacts, precautions and mitigation, Landslide and River bank Erosion – Mechanism and Control.

Human induced disasters –Industrial and chemical disasters, road/air/rail accidents, fire incidents, epidemics, disease outbreaks, alcoholism and suicides, violence, occupational health hazards, poverty, urban slum, migration and refugees, conflict, terrorism. Adaptation Strategies.

UNIT III: Disaster Management and Disaster Mitigation

Concept of disaster management; International Decade for Natural Disaster Reduction (IDNDR), Hyogo framework, Disaster prevention through Sustainable development and community participation.

Concept of mitigation and preparedness, Institutional framework for disaster preparedness and mitigation- Global and Indian scenario, Training Need Analysis and Human Resource Development Plan, Family disaster plan, Applications of GIS and GPS 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.

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.

Reference 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.