HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR-177001 (INDIA)

SYLLABUS

FOR

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE

(M.Sc. in Environmental Science)

(Two Years Programme)

(Spread Over Four Semesters)

FIRST TO FOURTH SEMESTER

SYLLABUS SCHEME

M.Sc.-Environmental Science

FIRST YEAR
SEMESTER-I

Sr. No	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							Internal Assessment			ESE	Subject Total
							CT	TA	Total		
CORE COURSES											
1	EVS-411	Introduction to Earth Processes	4	-	-	4	20	20	40	60	100
2	EVS-412	Ecology and Environment	4	-	-	4	20	20	40	60	100
3	EVS-413	Environmental Chemistry	4	-	-	4	20	20	40	60	100
4	EVS-414	Natural Resources Conservation	4	-	-	4	20	20	40	60	100
5	EVS-41L-I	Environmental Science Lab-I			4	4	20	20	40	60	100
FOUNDATION COURSES											
6	EVS-SD-I	*Skill Development-I	2	-	-	2	10	10	20	30	50
7	EVS-HM-I	**Human Making-I	2	-	-	2	10	10	20	30	50
TOTAL CREDITS			20	-	4	24	120	120	240	360	600

*Skill Development-I:

(i)Environmental Risk Assessment

**Human Making-I

(i)Waste Management Techniques

Legend:

L	Lecture
T	Tutorial
P	Practical
CT	Class Test
TA	Teachers Assessment
ESE	End Semester Examination
SD	Skill Development
HM	Human Making

M.Sc. -Environmental Science

FIRST YEAR
SEMESTER-I

Max. Marks: 600

Core Courses

		ESE +IA
EVS-411:	**Introduction to Earth Processes**	**60+40**
EVS-412:	**Ecology and Environment**	**60+40**
EVS-413:	**Environmental Chemistry**	**60+40**
EVS-414:	**Natural Resources Conservation**	**60+40**
EVS-41L-I:	**Environmental Science Lab-I**	**60+40**

Foundation Courses

EVS-SD-I:	**Skill Development-I**	**30+20**
EVS-HM-I:	**Human Making-I**	**30+20**

M.Sc.-Environmental Science

Semester-I

CORE COURSES:

EVS-411: INTRODUCTION TO EARTH PROCESSES

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Note:

The question paper for the final examination will consist of five sections-A, B, C, D&E. Section A, B, C, D will have two questions each from the corresponding units I,II,II&IVof the syllabus. Section E in the paper will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit I: Introduction to Earth Science

The role of earth science, Importance of minerals in everyday life, Evolution of various branches of Earth Science, Earth as a dynamic system, Earth, Man and Environment. Introduction to the planetary system, Different theories of origin and evolution of earth, Origin of atmosphere, water and life, Geological time scale, Primary differentiation and multilayer structure of Earth.

Unit II: Rock and Minerals

An overview on different rock types, Different mineral groups: Silicate and Non Silicate, Physical properties of mineral, Mohs hardness scale.

Unit III: Plate Tectonics

The concept of Hypothesis and Theory, Continental Drift hypothesis, Theory of Plate tectonics, Mountain building and sea floor spreading processes, Distribution of earthquake and volcanic activity across the globe.

Unit IV: Oceanography

Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains, Physical and chemical properties of sea water and their spatial variations, Ocean currents, waves and tides.

Text Books:

1. Tarbuck E. J. and Lutgens F. K. (1996). An introduction to Physical Geology. Prentice Hall, New Jersey; ISBN 0-13-371584-1

2. Kumar K. (1998). Course Material of "Foundation Course in Disaster Management" of School of Social Sciences - Indira Gandhi National Open University; ISBN 81-7605-236-X to ISBN 81-7605-248- X

3. Valdiya K. S. (1987). Environmental Geology (Indian Context). Tata-McGraw-Hill, New Delhi

Reference Books

1. Coates Donald R. (1985). Geology and Society. Chapman and Hall, NY

2. Keller Edward A. (1996). Environmental Geology. Prentice-Hall, NJ

3. Valdiya K. S. (2001). Geology, Environment and Society. University Press, Hyderabad

EVS -412: ECOLOGY AND ENVIRONMENT

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Note:

The question paper for the final examination will consist of five sections-A, B, C, D&E. Section A, B, C, D will have two questions each from the corresponding units I,II,II&IV of the syllabus. Section E in the paper will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT I

Scope and Introduction: Subdivisions, major landmarks in Ecology, levels of organization hierarchy; Organisms and Environment-Holocoenotic nature of environment; biotic and abiotic components. Population characteristics-Population Size and Density, Dispersion, Age structure, Natality, Mortality and Life Tables; population dynamics and concept of carrying capacity; Regulation of population growth.

UNIT II

Community Ecology: Community concept and brief classification, community characteristic, characters used to describe community structure- analytical, qualitative and synthetic characters, methods of community studies, species diversity α, β and ϒ); concept of ecological niche- types, ecotone & edge effect.

UNIT III

Community Development: Ecological succession-concept, causes and trends; Basic types of succession, General process of succession, Hydrosere, Lithosere, Heterotrophic succession, Ecosystem Development, concept of climax, Biome.

UNIT IV

Ecosystem Organization and Management: Concept of Ecosystem, Trophic structure of ecosystem, Examples of Ecosystem-A pond and an Old field or grassland ecosystem, Ecological pyramids-Pyramids of number, biomass and energy, Productivity of Ecosystem-Primary, Secondary and Net Productivity, Grazing and detritus food chains, Food web, Energy flow in ecosystem (simplified energy flow diagram depicting three trophic levels in a linear food chain), Biodiversity hot spots-Concept, brief introduction to biodiversity hot spots of India.

Text Books:

1. *Singh, H.R. and Kumar Neeraj (2006). Ecology and Environmental Sciences : Vishal Publishing Co. Books Market Road (Gumbeer Market) , Old Railway Road,Jalandhar -144008 (Punjab)*

2. *Sharma , P.D.(2010) . Ecology and Environment : Rastogi Publications , Gangotri Shivaji Road , Meerut -250002 (U.P)*

3. *Edward , J. Kormondy (2009) .Concept of Ecology : Published by : PHI Learning , Private Limited , New Delhi -110001*

EVS- 413: ENVIRONMENTAL CHEMISTRY

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Note:

The question paper for the final examination will consist of five sections-A, B, C, D&E. Section A, B, C, D will have two questions each from the corresponding units I,II,II&IV of the syllabus. Section E in the paper will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT I

Stochiometry, Gibbs' energy, chemical Potential, chemical equilibrium acid base reactions, Solubility product, solubility of gases in water, the carbonate system, Unsaturated and saturated hydrocarbons, radio nuclides.

UNIT II

Chemical compositions of Air: Classification of elements, chemical speciation, Particles, Ions and radicals in atmosphere, chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reaction in atmosphere Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog.

UNIT III

Water Chemistry: Chemistry of water, Concept of DO, BOD, COD, Sedimentation coagulation, filtration, redox potential. Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils.

UNIT IV

Main and transition metals Chemistry, Metal- Ligand concept and its implication towards biochemistry of metals.

Prescribed Text Books:

1. *Manahan, Stanley E. "FRONTMATTER"Environmental Chemistry Boca Raton: CRC Press LLC, 2000.*
2. *A K De Environmental Chemistry 4th Edition, New Age International (P) Ltd., New Delhi 110 002.*
3. *J. E. Girard, Principal of Environmental Chemistry (II Edition) Jones and Bartlett Learning, Delhi 110 002; ISBN 978-93-80108-12-4.*

4. *Siegfried H ubener, Encyclopedia of Inorganic Chemistry (3ed,AP)Forschungszentrum Rossendorf; ISBN 128-53-80108-11-0.*

Suggested Additional Readings:

1. *Jayaraman, J., Laboratory Manual in Biochemistry, New Age International (P) Limited.*
2. *Puri Sharma & Kalia, Principles of Inorganic Chemistry, S. Chand and company, N Delhi.*
3. *Keith Bucher, Global Climate, Wiley, New York 1976.*
4. *J. Heichlen, Atmospheric Chemistry, Academic Press, New York 1976.*
5. *Levin, Aerosol pollution impact on precipitation. New York Springer, 2009.*
6. *Rao,M N Air pollution, New Delhi: TMH, 2010.*
7. *Bali, J.S Bioindustrial watershed management. New Delhi: JCS, 2005.*
8. *Marcos,Ronand Biological waste water treatment in warm climate regions.London: IWA, 2006.*
9. *Rogers,J. Environment and water resources.USA: ASCE, 2007.*
10. *Manahan,Stanley Environmental chemistry. Boca Raton: CRC, 2010.*
11. *O'neill, Environmental chemistry.-- London: Blackie, 2009.*
12. *Srivastava,Manish Environmental chemistry.-- Delhi: Sree, 2009.*
13. *Vanloon,Gary Environmental chemistry.-- New York: Oxford, 2009.*
14. *Vanloon,Gary W, Environmental chemistry.-- New York: Oxford, 2010.*

EVS- 414: NATURAL RESOURCES CONSERVATION

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Note:

The question paper for the final examination will consist of five sections-A, B, C, D&E. Section A, B, C, D will have two questions each from the corresponding units I,II,II&IV of the syllabus. Section E in the paper will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT I

Introduction to Natural Resource Bases, Concept of resource, classification of natural resources, Factors influencing resource availability, distribution and uses, Need for Conservation of Natural Resources, Current status of natural resources.

UNIT II

Water Resources, degradation of water, conservation of water, Wildlife, need and methods for the conservation of wildlife, wildlife reserves in India and legislation for wildlife conservation, Ocean, Land Resources, Minerals, Soil Erosion Causes of soil Erosion Conservation of Soil

UNIT III

Biological Resources, threat to biodiversity, conservation of biodiversity, Energy, Types of energy resources, conventional and non conventional source of energy, bio fuel and its advantages, Human Resource.

UNIT IV

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

TEXT BOOKS

1. ***Chiras** D D**, Reganold** J Pand **Owen** O S**. Natural resource Conservation: Management for a sustainable future.** Prentice Hall Publishers, **ISBN** 0-13-145832.*
2. ***Kesler** S E. **Mineral resources Economics and the Environment**. Prentice Hall Publishers (Pearson Education),**ISBN**: 0023628421.*
3. ***Gangstad** E O 1990. **Natural resource management of water and land**. Van Nostrand Reinhold. ISBN 0442004818, 9780442004811*

EVS 41L-1: ENVIRONMENTAL SCIENCES LABORATORY – I

[4 Credits]

Laboratory experiments based on the theory courses to be taught in Semester-I

FOUNDATION COURSES:

EVS-SD-I: ENVIRONMENTAL RISK ASSESSMENT

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)
Time-2 Hours

Note:

The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.

Unit I: Environmental Quality Assessment and Monitoring

Introduction, Environmental protection standards in India, International standards, Environmental quality monitoring: ISO-14000; ISO-14000-impact on developing countries.

Unit II: Environmental Risk Assessment

Concept; Risk evaluation-Hazard identification, exposure and hazard assessment, Environmental Impact Assessment (EIA) .Concept, origin and scope of EIA; EIA in developing countries, Methodology and objectives of EIA; National environmental policy and statutory requirements of EIA, the Environmental Impact Assessment Notification.

Unit III: Environmental Legislations

Wild Life (Protection) Act, 1972, the Environment (Protection) Act, 1986, Biological Diversity Act, 2002

Text Books:

Purohit , S.S. , Shammi , Q.J. and Agrawal , A.K. (2007) . Environmental Sciences: Published by : Student Edition , Behind Nasrani Cinema , Chopasani Road , Jodhpur - 342003 (Rajasthan)

Manoharachary , C. and Reddy , Jayarama P.(2008).Principles of Environmental Studies : Published by: B S Publications , 4-4-309 , Giri Raj Lane , Sultan Bazar , Hydrabad – 500095 (A.P.)

Anjoneyulu , Y. and Monicleam Valli (2008). Environmental Impact Assessment Methodologies: Published by: B S Publications, 4-4-309, Giri Raj Lane, Sultan Bazar Hydrabad – 500095 (A.P.)

EVS-HM-I: WASTE MANAGEMENT TECHNIQUES

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)
Time-2 Hours

Note:

The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.

Unit-I: Biodegradable and Non Biodegradable solid waste

Chemical composition and classification, Source and generation, Health hazards, Management Techniques. Sources, generation, chemical composition, classification of plastic waste and its management. Sources, generation, chemical composition, classification of e - waste and its management.

Unit-II: Hospital and Pharmaceutical Waste

Classification, Source and generation, Health hazards, Management Techniques

Unit-III: Waste minimization technologies

Reuse/ recycling of different types of waste, Metal recovery from waste using chemical, biological and hybrid techniques

Text Books:

1. *Kreith, Frank (ed.) (1994) Handbook of Solid Waste Management, McGraw-Hill, Inc., New Delhi.*
2. *Pant D., Electronic Waste Management Lambart Academic Publishing 2010 (ISBN 978-3-8433-8336-3) .*
3. *Pant D., Pharmaceutical Waste Management Lambart Academic Publishing 2011 (ISBN 978-3-8454-4089-7)*

Suggested Additional Readings:

1. *Holmes, John R. (ed.) (1983) Practical Waste Management, John Wiley & Sons, New York/Singapore.*
2. *III. Harrison, M. Roy (ed.) (1995) Pollution; Causes, Effects and Control. The Royal Society of Chemistry, Cambridge cb4 4wf.*

M.Sc. Environmental Science
2nd Semester

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							Internal Assessment			ESE	Subject Total
							CT	TA	Total		
CORE COURSE											
1	EVS-415	Atmospheric Sciences	4	-	-	4	20	20	40	60	100
2	EVS-416	Global Environmental Issues and Environmental Legislation	4	-	-	4	20	20	40	60	100
3	EVS-417	Environmental Engineering	4	-	-	4	20	20	40	60	100
4	EVS-418	Hydrology and Water Resources	4	-	-	4	20	20	40	60	100
LAB											
5	EVS-41L-2	Environment Lab 2	-	-	4	4	20	20	40	60	100
GENERIC ELECTIVE											
6	EVS-SD-II	*Skill Development-II	2	-	-	2	10	10	20	30	50
7	EVS-HM-II	**Human Making-II	2	-	-	2	10	10	20	30	50
TOTAL CREDITS			20	-	4	24	120	120	240	360	600

***Skill Development-II: (i) Remote Sensing and GIS**

****Human Making-II: (ii) Basics of Environmental Sciences**

Legend

L	Lecture
T	Tutorial
P	Practical
CT	Class Test
TA	Teacher Assessment
ESE	End Semester Examination

M.Sc. - Environmental Science
2nd Semester

Max. Marks: 600

Core Courses		**ESE+IA**
EVS-415:	Atmospheric Sciences	60 + 40
EVS-416:	Global Environmental Issues and Environmental Legislation	60 + 40
EVS-417:	Environmental Engineering	60 + 40
EVS-418:	Hydrology and Water Resources	60 + 40
Lab		
EVS-41L-2:	Environment Lab 2	60 + 40
Generic Elective		
EVS-SD-II:	Skill Development-II	30 + 20
EVS-HM-II:	Human Making-II	30 + 20

EVS-415: ATMOSPHERIC SCIENCES

M.Sc. Environmental Sciences **Credits: 4**
2nd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Vertical Structure and Composition of Atmosphere

Chemical Composition, the State of the Atmosphere, Atmospheric Density and Pressure, Hydrostatic Balance

Unit 2: Atmospheric Thermodynamics

The Ideal Gas Law and First Law of Thermodynamics, Concept of Air Parcel and Lapse Rates, Atmospheric Stability, Mixing Height and Inversion

Unit 3: Atmospheric Energy Balance

Electromagnetic Radiations, Black Body Radiation, The Solar Constant and the Budget of Solar Radiation, Terrestrial Radiation, The Earth's Radiative Energy Balance, Green House Effect

Unit 4: Atmospheric Chemistry

Thermo-chemical and Photo-chemical Reactions, Chemistry of Stratosphere, Stratospheric Ozone Depletion, Chemistry of Troposphere, Acid Rain, Atmospheric Aerosols, Atmospheric Trace Gases

Unit 5: Atmospheric Dynamics

Pressure Belts and Winds, Pressure Gradient Force, Coriolis Force, Centrifugal Force, Frication, Global Circulation

Suggested Readings:

1. **Murry L. Salby** (2012): Physics of the Atmosphere and Climate, **Cambridge University Press**, ISBN: 978-0521767187

2. **Wallace John M. Jr., Peter V. Hobbs** (2006): Atmospheric Science: An Introductory Survey, 2nd Edition, **Academic Press**, ISBN: 978-0127329512

3. **John Green** (2011): Atmospheric Dynamics, **Cambridge University Press,** ISBN: 978-0521249751

4. **Frederick K. Lutgens, Edward J. Tarbuck** (2010)**:** The Atmosphere: An Introduction to Meteorology, **Phi (Prentice-hall New Arrivals)**, ISBN: 978-8120344150

5. **Mark Z. Jacobson** (2005): Fundamentals of Atmospheric Modeling, **Cambridge University Press,** ISBN: 978-0521548656

6. **John H. Seinfeld, Spyros N. Pandis** (2006)**:** Atmospheric Chemistry and Physics, **John Wiley & Sons Inc.,** ISBN: 978-0-471-72018-8

EVS-416: GLOBAL ENVIRONMENTAL ISSUES AND ENVIRONMENTAL LEGISLATION

M.Sc. Environmental Sciences **Credits: 4**
2nd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Environmental Education and Issues

Environmental education, awareness, ethics and global imperatives, Global environmental problems: Ozone depletion, Global warming, Climate change, Desertification and its control, Depletion of Natural resources, Wet land conservation, Water Crises-Conservation of water, Eutrophication and restoration of Lakes, Epidemiological issues.

Unit 2: International Conventions and Protocols

The Kyoto Protocol to the UN Convention on Climate Change, Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and Their Disposal, The Convention on Biological Diversity, Convention on Long-Range Tran boundary Air Pollution, The Montreal Protocol on Substances that Deplete the Ozone Layer and the United Nations Convention to Combat Desertification.

Unit 3: Environmental Constitutional Perspective

International Perspective of Human right to environment from Stockholm 1972 to Rio 1992 and beyond; Johannesburg Summit 2002, Delhi Summit 2002, Brundtland report 1987.
Fundamental right to wholesome environment: Article 14, 19 (1) (g), 21 & 32 of the constitution. Directive principles of state policy-Article 47, 48A of the constitution. Fundamental duty-Article 51A (g) of the constitution.

Unit 4: Environmental Protection Legislations

The Water (Prevention and control of Pollution) Act 1974 as amended up to 1988 and Rules 1975; The Air (Prevention and Control of Pollution) Act 1981, Amendment Act 1987 and rule 1982; The Environment (Protection) Act 1986; Forest Act 1927; Forest Conservation Act 1980; Indian Forest Act (Revised) 1982, The Wild life Protection Act 1972 and Amendment 1991, 2002; Biodiversity Act 2002; The Noise Pollution (Regulation) 2000; Hazardous waste management and handling rules 1989; Motor Vehicle Act 1988; Public Liability insurance Act 1991 rules 1991.

Suggested Readings:

Bell Stuart & Mc Gillvray Donal, 2001, Environmental Law, Universal Law Publishing Co.
Diwan Shyam and Rosencranz Armin, 2002, Environmental Law and Policy.
Mohanty. S. K., 2004, Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.
Singh Gurdip, 2004, Environmental Law in India, Mcmillan & Co.
Shastri. S. C., 2005, Environmental Law, Eastern Book Company.
Smith, P. and Warr, K., 1991, Global Environmental issues, Hodder and Stoughton, London.

EVS-417: ENVIRONMENTAL ENGINEERING

M.Sc. Environmental Sciences **Credits: 4**
2nd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Mass and Energy Transfer
- Concentrations and other units of measure, Material Balance
- Thermodynamics, Chemical Equilibrium

Unit 2: Air, Water and Their Impurities
- Air and the Atmosphere, - Water and the Hydrosphere
- Water Pollutants
- Air Pollutants

Unit 3: Air Quality Engineering
- Air Pollutant Emissions and Controls, - Pollutant generation by combustion, - Motor vehicle emissions
- Treatment Technologies, - Particle control devices, - Absorption for gaseous pollutant

Unit 4: Water Quality Engineering
- Water Quality Regulations and Treatment Systems
- Physical Treatment Methods
- Chemical and Physicochemical Treatment Methods
- Biological Waste Water Treatment

Unit 5: Global Climate Change and Geo-engineering
- Green House Effect, Radiative Forcing, Global warming Potential
- Global Energy Balance, Global Warming
- Climate Change
- Mitigation Strategies, Geo-engineering

Suggested Reading:

Gilbert M. Masters, Wendell P. Ela (2008): Introduction to Environmental Engineering and Science, **PHI Learning,** ISBN: 978-8120336919

P. Venugopala Rao (2004): Textbook of Environmental Engineering, **Phi Learning**, ISBN: 978-8120319301

David A. Cornwell, Mackenzie L. Davis (2010): Introduction to Environmental Engineering, **Tata McGraw-Hill Education,** ISBN: 978-0070671171

K. N. Duggal (2008): Elements of Environmental Engineering, **S. Chand Publishing,** ISBN: 978-8121915472

EVS-418: HYDROLOGY AND WATER RESOURCES

M.Sc. Environmental Sciences **Credits: 4**
2nd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Hydrology
Introduction: Hydrology, The hydrologic cycle; Structure and properties of water. Hydrogeology of India. Application of isotopes in hydrology. Inventory of Earth's water, quality and quantity. Limits of cations and anions in portable water including fluoride and arsenic, phosphate, nitrate and heavy metals.

Unit 2: Surface and Groundwater Resources and their Properties
Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff,
Drainage basin. Groundwater resources: rock properties affecting ground water, vertical distribution of ground water, zone of saturation. Darcy's law: permeability, transmissivity and storage coefficient. Viscous character of groundwater flow. Geologic formations as aquifers, type of aquifers. Distribution of water - local, regional and global. Ground water exploration.

Unit 3: Environmental Influences on water resources
Surface and groundwater resources of arid and semiarid regions, Snowmelt hydrology from glaciers, fluctuations due to urbanization, Evapo-transpiration and tides. Recent development in surface and groundwater resources monitoring and assessing processes. Water logging and soil salinity-conjunctive use of surface water and ground water.

Unit 4: Water resource management
Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment. Wetland and riparian management; forest management on water resources.

Suggested Readings:
Aggarwal, A., 1991, Floods, Floodplains and Environmental Myths. Centre for Science and Environment, New Delhi.

Andrew D. Ward and Stanley Trimble, 2004, 2nd Ed., Environmental Hydrology, Lewis Publishers.

Karanth, K.R.C., 1988, Ground Water: Exploration, Assessment and Development. Tata-Mcgraw Hill, New Delhi.

Mahajan, G., 1989, Evaluation and Development of Groundwater. Ashish Publishing House, New Delhi.

EVS-SD-II: *SKILL DEVELOPMENT-II: (I) REMOTE SENSING AND GIS

M.Sc. Environmental Sciences **Credits: 2**
2nd Semester **Total Marks: 50**
(IA: 20 + ESE: 30)

Course Content

Unit 1:
What is Remote Sensing, Electromagnetic Radiation, Electromagnetic Spectrum, Interactions with the Atmosphere, Radiation – Target, Passive vs. Active Sensing, Characteristics of Images

Unit 2:
Sensors on the Ground, in the air, in Space, Satellite Characteristics, Pixel Size and Scale, Different Resolutions, Cameras and Aerial Photography, Different Satellites, Other Sensors

Unit 3:
Radar Basic, Viewing Geometry & Spatial Resolution, Airborne vs Spaceborne Radars, Airborne & Spaceborne Radar Systems

Unit 4:
Image Analysis: Visual interpretation, Digital processing, Preprocessing, Enhancement, Transformations, Classification, Integration

Unit 5:
Applications: Agriculture, Glaciology, Forestry, Geology, Hydrology, Sea Ice, Land Cover, Biomass Mapping, Oceans & Coastal

Suggested Readings:

Lillesand & Keifer, (2011): Remote Sensing & Image Interpretation, **John Wiley & Sons**, ISBN: 9788126532230.

James B.Campbell,(2007): Introduction to Remote Sensing, **Taylor & Francis,** ISBN: 9780415416887.

J**.R. Jensen,** (2009): Remote Sensing of the Environment, **Pearsons education Pub.** ISBN: 9788131716809.

George Joseph, (2005): Fundamental of Remote Sensing, **University Press, India**, ISBN: 9788173715358.

Bruce Grubbs, (2005): Basic Essentials Using GPS, **Falcon Press Publishing,** ISBN: 9780762734214.

EVS-HM-II: **HUMAN MAKING-II: (II) BASICS OF ENVIRONMENTAL SCIENCES

M.Sc. Environmental Sciences **Credits: 2**
2nd Semester **Total Marks: 50**
(IA: 20 + ESE: 30)

Course Content

Unit 1
Connecting to the issue of environment; ecology of environment; components of environment and their interactions; human-environment interface, relationship dynamics and resource conflicts. Environmental Science – definition, principles and scope, multidisciplinary approach – chemistry, physics, biology, mathematics. Environmental ethics and role of education in solving environmental issues.

Unit 2
Atmosphere, Hydrosphere, Lithosphere and Biosphere - Definition, Structure and composition; Structure of Environment.

Unit 3
Green House Effect - Greenhouse gases its sources, impacts, consequences and remedial measures; global warming. Global Climate change, World and Indian scenario, Acid Rain; Brown Haze, Photochemical smog, nuclear winter; Ozone depletion.

Unit 4
Bhopal gas tragedy, Fukushima and Chernobyl disaster, Love Canal tragedy, Minimata Accident, Creation of UNEP and its role, World earth summits; Agenda 21, UNFCCC, Convention on Biodiversity and Convention on Climate Change, CoPs, Climate Change and Global Warming; IPCC and its reports

Suggested reading

Ahluwalia, V. K. (2015). Environmental Studies: basic concepts. The Energy and Resources Institute (TERI).
Beheim, E., Rajwar, G. S., Haigh, M. and Krecek, J. (Eds.). (2012). Integrated watershed management: Perspectives and problems. Springer Science & Business Media.
Bhatt, S. (2004). Environment protection and sustainable development. APH Publishier
Burchett, S. and Burchett, S. (2011). Introduction to wildlife conservation in farming. John Wiley & Sons.
Das, S. K. (2008). Watershed development and livelihoods: people's action in India. Routledge India.
Fa, J. E., Funk, S. M., & O'Connell, D. (2011). Zoo conservation biology. Cambridge University Press.
Fatik B.M. and Nepal C. (2009). Nandi. Biodiversity: concepts, conservation and biofuture, Asian Books

M.Sc. Environmental Science
3rd Semester

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							Internal Assessment			ESE	Subject Total
							CT	TA	Total		
CORE COURSE											
1	EVS-419	Glaciology	4	-	-	4	20	20	40	60	100
2	EVS-420	Environmental Impact Analysis	4	-	-	4	20	20	40	60	100
3	EVS-421	Natural hazards and disaster management	4	-	-	4	20	20	40	60	100
4	EVS-422	Solid and Hazardous waste Management	4	-	-	4	20	20	40	60	100
LAB											
5	EVS-41L-3	Environmental Lab 3	-	-	4	4	20	20	40	60	100
INTERDISCIPLINARY ELECTIVE											
6	EVS-41 ID-I (A to C)	*Interdisciplinary and Applied Sciences-I	4	-	-	4	20	20	40	60	100
TOTAL CREDITS			20	-	4	24	120	120	240	360	600

***Interdisciplinary and Applied Sciences-I (Choose any one)**

(A) Biodiversity Conservation and Management

(B) Basic of computer Application and Environmental Statistics

(C) Intellectual Property Rights

M.Sc. - Environmental Science
3rd Semester

Max. Marks: 600

Core Courses		**ESE+IA**
EVS-419:	Glaciology	60 + 40
EVS-420:	Environmental Impact Analysis	60 + 40
EVS-421:	Natural hazards and disaster management	60 + 40
EVS-422:	Solid and Hazardous Waste Management	60 + 40
Lab		
EVS-41L-3:	Environmental Lab 3	60 + 40
Interdisciplinary elective		
EVS-41 ID-I:	*Interdisciplinary and Applied Sciences-I	60 + 40

EVS-419: GLACIOLOGY

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Glaciology

Glacier systems- Structure and morphology of glaciers- Classification and types of glaciers, Crevasses and icefall, moraines, criques, dead ice. Transformation of snow in to ice, Zones in glacier, areal distribution of glaciers/snow cover and factors controlling the distribution of snow cover.

Unit 2: Paleoglaciation and Glacier landforms

Milankovitch cycles and Greenhouse effect, Little ice age (LIA), Glacial and interglacial cycles, Depositional and erosional Glacial landforms, Avalanches, Surging glaciers, tide water glaciers, Permafrost, Ice sheets, Ice stream and ice shelves.

Unit 3: Glacier Mass Balance

Mass balance- Glacier dynamics, Englacial and subglacial process and fluctuations- Stake method, Geodetic method, ELA, AAR methods, Glacier hydrology methods, Snow and melt water chemistry of Glaciers.

Unit 4: Approaches to Glaciology

Approaches to Glaciology- Glacier modeling, Glacier and climate change impact, Glacier and water resources, Recent advances in Glaciology, Glacier Hazards, Glaciers as tool for palaeo climate studies.

Suggested Readings:

Michael J. Hambrey (1994). Glacial Environment, UBC Press Limited Canada, University of British Columbia, ISBN 0-7748-0509-9.

Robert P. Sharp (1988). Living ice: Understanding Glaciers and Glaciation, Cambridge University Press, New York, ISBN 0-521-30009-2.

Duglas I. Ben and David J.A. Evans (2010), Glaciers and Glaciation. Published by Hodder Education, Taylor and Fransic, ISBN 13: 978-0-340-90579-1.

EVS-420: ENVIRONMENTAL IMPACT ANALYSIS

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to EIA and Environmental Planning
Origin, aims and needs of EIA, EIA guidelines 1994, EIA notification and amendments; Environmental Impact Assessment (EIA) as a tool in environmental management, EMS, ISO 14001. Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies.

Unit 2: EIA Methodology
Types of Projects requiring Environmental Clearance, Types of EIA, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Mitigation measures. Public participation, review and decision making, Generic structure of EIA Document, Composition of EAC, SEAC, Benefits and future of EIA.

Unit III: Environmental Audit
Introduction, concepts, steps, methodology. Environmental Auditing: Procedure, Matrix methods and Batelle method of auditing, National Environmental Policies and guidelines for environmental audit in India, Environmental impact statement

Unit IV: **Case Studies**
Environmental Impact Assessment of major developmental projects – river valley projects, mining projects, thermal power plants, transport (rail, road highway), oil refineries and petrochemicals. Prediction and assessment of impacts on the biological, cultural and socio-economic environments

Suggested Readings:

Glasson, J. Therivel, R. and Chadwick, A. (2006). Introduction to Environmental Impact Assessment. Routledge, London.

Jain, R.K., Urban L.V. and Stacey, G.S. (1981). Environmental Impact Analysis: A New Dimension in Decision Making. Van Nostrand Reinhold Company, New York.

Kreske, D.L. (1996). Environmental Impact Statemement: A practical guide for agencies, citizens and consultants. John Wiley and Sons Inc., New York.

Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.

Petts, J. (2005). Handbook of Environmental Impact Assessment-Volume 1 and 2, Blackwell Publishers, UK.

EVS-421: NATURAL HAZARDS AND DISASTER MANAGEMENT

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Hazards

Hazard Classification – Natural hazards and Technological hazards, Effects of hazards, Vulnerability and susceptibility of hazards, Assessing hazards and risks, Hazard prediction and warning, A brief introduction to biological hazards- Biological warfare, Anthrax.

Unit 2: Earthquakes, Landslides and Volcanoes

Earthquakes - Types and Distribution of earthquakes, Prediction and control of earthquakes, Tsunami, mass movements; types, affecting factors, prediction, prevention & control and effect of mass movements. Volcanoes-Distribution, types, eruption processes, Factors, Products.

Unit 3: Water related hazards

Different kinds of floods, Factors leading to floods, Factors affecting floods, Floods and their associated hazards, Flood control measures, Prediction of floods. Factors leading to drought, drought consequences, strategies for drought mitigation, Desertification – Factors causing desertification, famine, El Nino and their effects.

Unit 4: Weather related Hazards

Effects of cyclones, genesis of a cyclone, Behavior of a cyclone and their forecast, Factors affecting cyclone hazards, Structure of a tropical cyclone, Size of tropical cyclones, Cyclone risk and mitigation strategies, Storm surge, Hurricane, cyclones and tornadoes, thunderstorms, lightening.

Suggested Readings:

Abbott, Patrick L. 2004. Natural disasters. 4th ed. Boston, McGraw-Hill Higher Education. Alexander, David. 2000. Confronting catastrophe: new perspectives on natural disasters. New York, Oxford University Press.

Allison, I. S. and Palmer, D. F. 1980. Geology, the science of a changing Earth. VII Edition. McGraw-Hill Inc.

Cesare Emiliani 1992. Planet Earth -Cosmology, geology and the evolution of life and the environment. Cambridge University press U.K.

Robinson, A.G. 2002. Earthshock: hurricanes, volcanoes, earthquakes, tornadoes, and other forces of nature. Rev. Ed.New York,

Thames & Hudson, 2002. Smith, Keith. 2002. Environmental hazards: assessing risk and reducing disaster. 3rd ed. London, New York, Routledge.

EVS-422: SOLID AND HAZARDOUS WASTE MANAGEMENT

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Solid and Hazardous waste

Solid wastes: Definition, types, sources, characteristics, and impact on environmental health. Hazardous wastes: Definition, sources and characteristics, Hazardous waste categorization.

Unit 2: Handling and Legislation of Waste

Handling of Solid and Hazardous waste: Collection, segregation and transport of solid wastes at source, Collection, storage, segregation and transport of Hazardous waste, Legislation on management and handling of municipal solid wastes and hazardous wastes.

Unit 3: Waste minimization techniques

Concepts of waste reduction, recycling and reuse. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery. Composting, Vermicomposting, Incineration of solid wastes.

Unit 4: Landfills: Disposal/Treatment of wastes

Disposal in landfills: site selection, design, and operation of sanitary landfills; secure landfills and landfill bioreactors; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation.

Suggested Readings:

Kreith, Frank (ed.) (1994). Handbook of solid waste management. McGraw- Hill. Inc., New Delhi.

Kumar, S. (2016). Municipal Solid Waste Management in Developing Countries, Taylor and Francis, ISBN-13:978-1-4987-3774-6.

Michael D. LaGrega, Phillip l. Buckingham, Jeffrey C. Evans (2010). Hazardous Waste Management by Environmental Resource Management, ISBN 978-1-57766-693-6.

EVS-41 ID-I (A): BIODIVERSITY CONSERVATION AND MANAGEMENT

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course Content

Unit 1: Introduction to biodiversity

Ecosystems, Biomes, Biodiversity hotspots and their characteristic flora and fauna; Economic value of biodiversity. Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular), Ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity (equilibrium mix of *G* and W). Microbial diversity, Plant diversity, Agro biodiversity.

Unit 2: Biodiversity magnitude and distribution

Species diversity: richness and evenness, loss of species. Magnitude of biodiversity (Global and Indian data). Direct and indirect benefits, Bioprospecting; Genetic diversity; Mapping of biodiversity.

Unit 3: Threats to biodiversity

Threats to Biodiversity: Habitat loss and fragmentation; Disturbance and pollution; introduction of exotic species; extinction of species; Threatened plants and animals of India. IUCN threat categories, Red data book, Invasions- causes and effect.

Unit 4: Wildlife and its management

Significance of wildlife, Important wildlife species in different sub regions of India, Endangered Plant species of Himalayas, Causes of wildlife resource depletion in India, Important National Parks, Wildlife Sanctuaries and Biosphere reserves in India.

Unit 5: Conservation of biodiversity

Principles and strategies; in-situ and ex-situ conservation, Protected Area Network.

Suggested Readings:

Sharma, P.D. (2011) Ecology and Environment Eleventh Revised Edition

Dasman, R. F. (1982) Wildlife Biology: Wiley Eastern Lrd NDL.

Giles, R. H. (ed.) (1980) Wildlife Management Techniques: Pub. Natural Publ. Dehradun.

Deeksha, D and Katewa, S.S. (2012). Textbook of Environmental Studies: Cengage Learning India Pvt. Ltd.

EVS-41 ID-I (B): BASIC OF COMPUTER APPLICATION AND ENVIRONMENTAL STATISTICS

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course Content

Unit 1

Fundamentals of Computers: Block Diagram of Computer, Hardware Components, Introduction to computer network and World Wide Web.

Unit 2

Sharing Data over Network, Computer Configuration, Memory Hierarchy, Software Structure. Introduction to MS Paint, Notepad and Word.

Unit 3

Introduction to Word Processing and Microsoft Office, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management.

Unit 4

Spreadsheet applications, Presentation applications, Internet browsers and Image processing applications, Measures of central tendency- mean, mode and median; dispersion (including box and whisker plot), skewness and kurtosis., Probability, combinatorial problems, conditional probability, Binomial Distribution. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots; curve fitting; Hypothesis testing, t-test, z-test, $\chi 2$ test.

Suggested Reading

Harvey, G. (2016). Excel 2016 for dummies. John Wiley & Sons.

Sinha, P. K. and Sinha, P. (2010). Computer fundamentals (Vol. 4). BPB publications

Spiegel, M., and Stephens, L. (2007). Schaum's outline of statistics. McGraw Hill Professional.

Meyer, P. L. (1970). Introductory probability and statistical applications (No. 519.2 M4 1970).

Meyer, P. L. (1965). Introductory probability and statistical applications (No. 519.1 M4).

EVS-41 ID-I(C): INTELLECTUAL PROPERTY RIGHT

M.Sc. Environmental Sciences **Credits: 4**
3rd Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course Content

Unit 1 Introduction
Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

Unit 2 Registration of IPRs
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

Unit 3 Agreements and Legislations
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit 4 Digital Products and Law
Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

Suggested Reading:

V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012

S. V. Satakar, **—**Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002

M.Sc. Environmental Science
4th Semester

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							Internal Assessment			ESE	Subject Total
							CT	TA	Total		
CORE COURSE											
1	EVS-423	Meteorology and Climatology	4	-	-	4	20	20	40	60	100
2	EVS-424	Energy and Environment	4	-	-	4	20	20	40	60	100
3	EVS-425 (A to C)	Discipline Specific Elective-I	4	-	-	4	20	20	40	60	100
4	EVS-426 (A to C)	Discipline Specific Elective-II	4	-	-	4	20	20	40	60	100
PROJECT WORK/ Dissertation											
7	EVS-001	Dissertation (Field / Lab Work, Research, Report and Viva Voce)	4			4	20	20	40	60	100
TOTAL CREDITS			16+4			20	100	100	200	300	500

Discipline Specific Elective-I

A. Ecotoxicology and Occupational Safety Techniques
B. Introduction to Research Methodology
C. Biodiversity and Conservation Biology

Discipline Specific Elective-II

(A) Environmental Analytical
(B) Soil Biology
(C) Environment Pollution and Control

M.Sc. Environmental Science
4th Semester

Max. Marks: 600

Core Courses		**ESE+IA**
EVS-423:	Meteorology and Climatology	60 + 40
EVS-424:	Energy and Environment	60 + 40
EVS-425:	Discipline Specific Elective-I	60 + 40
EVS-426:	Discipline Specific Elective-II	60 + 40

PROJECT WORK/ Dissertation

EVS-001: Dissertation (Field / Lab Work, Research, Report and Viva Voce) 100

EVS-423: METEOROLOGY AND CLIMATOLOGY

M.Sc. Environmental Sciences
4th Semester

Credits: 4
Total Marks: 100
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Meteorology fundamentals

Thermal structure of the atmosphere and its composition, Pressure, temperature, wind and wind belts, humidity, virtual temperature, radiation, radiation from sun, solar constant, albedo, emission and absorption of terrestrial radiation, greenhouse effect, net radiation budget.

Unit 2: Atmospheric Air Dynamics

Atmospheric stability diagrams, turbulence, diffusion, thermodynamic diagrams, T-phigram and mixing height, thermodynamics of dry and moist air, specific gas constant, adiabatic and isoentropic processes, entropy and enthalpy, adiabatic processes of moist air.

Unit 3: Climatology Fundamentals

Classification of climate- Koppen's and Thornthwaite' scheme, Climatic types and their distribution, cloud formation and precipitation, fronts: frontogenesis and frontolysis, Air masses.

Unit 4: Atmospheric Disturbances

Monsoon, jet stream, cyclones and anticyclones, tropical disturbances: Hurricanes, Thunderstorms, Tornadoes, Applied climatology.

Suggested Reading:

Byers, H.R., General Meteorology, McGraw Hill, 1959.

Cole, F.W., Introduction to Meteorology, Wiley, 1975.

Lal, D.S., Climatology, Sharda Pustak Bhawan, Allahabad, ISBN 81-86204-12-1, 2003.

Griffith, J.F., Applied Climatology, Oxford University Press, 1966.

EVS-424: ENERGY AND ENVIRONMENT

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction
Introduction to energy sources, Energy scenario in world and India, Potential and perspectives of various energy sources in India, classification of energy resources-conventional and non-conventional, renewable and nonrenewable, environmental implications of energy resources.

Unit 2: Conventional energy
Fossil fuels (Coal, petroleum, LPG and natural gas) – origin, composition and physico chemical characteristics and energy content, sources properties and production process; nuclear energy– fission and fusion, technologies – nuclear enrichment, nuclear reactors, nuclear waste disposal, policies and regulations.

Unit 3: Non -Conventional energy
Prospects of renewable non-conventional energy, Types-solar energy, wind energy, hydel, tidal and geothermal energy, OTEC: introduction, principle, generation. Solar collectors, applications of solar energy: Solar water heating, solar heating and cooling of buildings, solar photo-voltaics, solar distillation, solar cooking and solar ponds. Basic components of wind energy conversion system, types and applications of wind energy.

Unit 4: Waste to Energy and Energy Conservation
Bioenergy - Biomass energy as an energy source, characteristics of biomass, Energy plantations, Biomass conversion technologies. Types of biofuels - Biodiesel, bioethanol, biogas, biohydrogen - importance, production, technologies and applications. Waste to resource recovery and recycling for energy, conversion technologies. Feed stocks, factors affecting biogas generation, Biogas plants: Classification of biogas plants, advantages and disadvantages of biogas plants, community biogas plants. Microbial fuel cell – principle, types and challenges. Environmental impacts of over exploitation of solar, wind and ocean energy. Energy conservation – principles and approach, energy conservation in buildings, green buildings, solar passive architecture, ecohousing, energy audit, national and international norms.

Suggested Reading:

Gupta, H. K., & Roy, S. (2006). Geothermal energy: an alternative resource for the 21st century. Elsevier.

Lal, B., and Sarma, P. M. (Eds.). (2011). Wealth from waste. The Energy and Resources Institute (TERI).

MNRE, Griha manual volume - 3: Technical manual for trainers on building and system design optimization renewable energy application, Ministry of New and Renewable Energy.

Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Seyboth, K., Kadner, S., Zwickel, T., Eickemeier, P., Hansen, G., Schlomer, S., von Stechow, C., and Matschoss P.(Eds). (2011). Renewable energy sources and climate change mitigation: Special report of the intergovernmental panel on climate change. Cambridge University Press.

EVS-425 (A): ECOTOXICOLOGY AND OCCUPATIONAL SAFETY

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1 Ecotoxicology

Ecotoxicology as a Synthetic Science; Major classes of Environmental Pollutants; Inorganic, Heavy Metals, Organics, Organometalics, Radioactive Isotopes, Gases Routes of Entry into Ecosystems – Surface waters, Land, Atmosphere; Long-range movement and global transport of pollutants. Fate of pollutants in Ecosystems: Biotransformation, Bioaccumulation & Biomagnification.

Unit 2 Analysis methods

Test organisms used in Bioassays. Biomonitoring: Definition of toxicity, F, As, Hg problems Toxicity Testing, Concept of Dosimetry: lethal, sub-lethal & chronic tests, dose response curves, LC50, MATC-NOEC, Brief statistical methodology Toxicant Effects: - Cellular, organismic, population & Ecosystem-Level Effects; Global Effects – Acid rain etc.

Unit 3 Environmental Health

Toxicology & Epidemiology and occupational health Sources: Solid & Hazarious wastes, untreated sewage, Automobile exhausts, Industrial Effluents, Industrial emissions into atmosphere, Agricultural run-off of Pesticides

Unit 4 Environmental Issues

Environmental Carcinogens, Mutagens, Asbestos issues Human adaptation to cold and hot climates, high altitude environment and man-made environments. Water pollution – Caused diseases (Gastroenteritis, Hepatitis etc.). Air pollution caused diseases (allergies, respiratory diseases). Food-borne diseases (Food poisoning, parasites etc). Vector transmitted diseases. Radioactive effects. Risk assessment

Suggested readings:

Newman, M.C, Lawrence, C.A., and Unger. M.A., 2002. Ecotoxicology: Fundamentals of Ecotoxicology, 2 nd Ed., CRC Press, Boca Raton, Florida.

Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2 nd Ed. Taylor & Francis, London. Environmental Health.

Moore, G.S., 2002, Living with the Earth: concepts in Environmental Health Science (2 nd Ed.), Lewis publishers, Michigan.

Selinus, Alloway, Centeno, Finkelman, Fuge, Lindh, Smedley; 2005, Essential of Medical Geology; Elsevier Academic Press.

EVS-425(B): INTRODUCTION TO RESEARCH METHODOLOGY

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1 - Introduction to Research

Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research; Research applications in social and business sciences; Features of a Good research study.

Unit 2 - Research Problem and Formulation of Research Hypotheses

Defining the Research problem; Management Decision Problem vs Management Research Problem; Problem identification process; Components of the research problem; Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal- Contents of a research proposal and types of research proposals.

Unit 3 - Research Design

Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross-sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design.

Unit 4 - Primary and Secondary Data

Classification of Data; Secondary Data: Uses, Advantages, Disadvantages, Types and sources; Primary Data Collection: Observation method, Focus Group Discussion, Personal Interview method.

Suggested Reading:

C. R. Kothari (2009) "Research Methodology: Methods & Techniques" (Second Revised Edition), New Age International Publishers, New Delhi.

Kothari C.R., Research Methodology Method and Techniques, New age international (p) Ltd., New Delhi, 2007.

EVS-425 (C): BIODIVERSITY AND CONSERVATION BIOLOGY

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Concept of Biodiversity
Concept of biodiversity, Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Ecosystems and Ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity, Species diversity: richness and evenness, Genetic diversity.

Unit 2: Threats to Biodiversity
Threats to Biodiversity: Habitat loss and fragmentation; Disturbance and pollution; introduction of exotic species; extinction of species. Human intervention and Biodiversity loss: Global Environmental changes, land in water use changes.

Unit 3: Biological Conservation
History of Conservation movements: International and National: IUCN categorized-endangered, threatened, vulnerable species. Red data book and related documentation, Methods of conservation. *In situ* (Biosphere reserves, National Parks, Sancturies, Sacred groves etc) & *ex situ* (Botanical gardens, Zoological gardens, Gene banks, Pollen, seed and seedling banks, tissue culture and DNA banks etc) modes of conservation.

Unit 4: Benefits of Biological Conservation
Benefits of conservation: Biodiversity as a source of food and improved varieties; source of drugs and medicines; Aesthetics and cultural benefits. Sustainable development. Ecosystems services: maintenance of gaseous composition of the atmosphere, climate control by forests, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water.

Suggested Reading:

Dobson, A.P., 1996, Conservation and Biodiversity. Scientific American Library, New York, NY.

Gaston, K J. and J.I. Spicer,1998, Biodiversity: An Introduction. Blackwell Science, London, UK.

Groom bridge, B., and M. Jenkins, 2000, Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.

Primack, R.B., 2002, Essentials of Conservation Biology, 3rd Edn., Sinauer Associates, Sunderland, Ma. USA

EVS-426 (A): ENVIRONMENTAL ANALYTICAL TECHNIQUES

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Introduction to Chromatography
Basic principle of Analytical techniques. Different types of Chromatography techniques and their applications. Thin layer Chromatography – Basic principle, methodology, application.

Unit 2: High Performance Liquid Chromatography
Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

Unit 3: Gas Chromatography
Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

Unit 4: Liquid and Gas Chromatography - Mass spectrometry
Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

Suggested readings:
Handbook of HPLC. Danilo Corradini, Elena Eksteen (Katz), Roy Eksteen, Peter Schoenmakers, Neil Miller. CRC Press.
[http://books.google.co.in/books/about/Handbook_of_HPLC.html?id=4mj_DArD5n0C]

Introduction to Modern Liquid Chromatography, 3rd Ed. Lloyd R. Snyder, Joseph J. Kirkland, and John W. Dolan. ISBN-13: 978-0470167540.
[http://www.lcresources.com/resources/resbooks.html]

EVS-426 (B): SOIL BIOLOGY

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1:

Definition of soil- Soil composition, Pedosphere, Soil organic matter: sources, composition, microbial decomposition of organic matter, Humus formation, Significance of soil fertility, Soil reaction- Biological properties of soil- nutrient availability.

Unit 2:

Soil as a habitat for organisms: micro flora and soil fauna, ecological interactions. Taxonomy and biology of soil organisms, Position and role of soil fauna in soil, ecological niche. Economic importance of soil microbes.

Unit 3:

Role of soil biota in nutrient cycles: Carbon, Nitrogen, Sulphur, Phosphorous cycles.
Soil mutualistic symbioses –Mycorrizal symbioses and Nitrogen fixing symbioses,
Underground interactions: Rhizosphere, root exudates

Unit 4:

Environmental problems related to soils in India: desertification, salinization, erosion. Bioremediation of contaminated soils and ground water, Fate of plant allelochemicals in soil, Composting, a value addition to our wastes.

Suggested Readings:

Alexander, M., 1977, 2nd Edn., Introduction to Soil Microbiology, Wiley John.

Alexander, M., 1994, Biodegradation and Bioremediation, Academic Press. 28

Coleman and Crossley, 2004, 2nd Ed., Fundamentals of Soil Ecology, Academic Press.

Killham, K., 1994, Soil Ecology, Cambridge University Press.

EVS-426 (C): ENVIRONMENT POLLUTION AND CONTROL

M.Sc. Environmental Sciences **Credits: 4**
4th Semester **Total Marks: 100**
(IA: 40 + ESE: 60)

Course contents

Unit 1: Waste water management

Primary treatment methods– screening, grit removal, primary sedimentation, secondary treatment methods, activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons. Advance waste water treatment, removal of nutrients and solids. Wastewaters reuse and sludge disposal, MINAS

Unit 2: Air Pollution control

Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electro static precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion. High Volume Air Sampler, Major air pollutants in India.

Unit 3: Noise Pollution Control

Basics of sound, Sound propagation, Measurement of noise and indices, Effect of meteorological parameters on noise propagation. Noise control and abatement measures, Noise exposure levels and standards, Impact of noise on human health.

Unit 4: Solid and Hazardous Waste Management

Sources, Chemical composition and Classification of solid wastes, Solid waste management options: Sanitary Landfill, Recycling, Composting, Incineration, Energy recovery options from organic wastes. Hospital waste management; Fly ash management, Municipal Solid waste. Classification of Hazardous wastes, Physico-chemical, Hazardous waste control and treatment, Different methods of disposal and management of hazardous wastes.

Suggested Readings:

Dara, S.S. (1995). A Text Book of Environmental Chemistry and Pollution Control, S. Chand, and Co. Ltd., New Delhi.

Harrison, R.M. (2014). Pollution: Causes, Effects and Control. 5th Edition, RCS Publishing.

Krishnan Kannan Ed. (1994). Fundamentals of Environmental Pollution, S. Chand & Company Ltd., Ramnagar, New Delhi.

Spellman, F.R. (2017). The Science of Environmental Pollution. Taylor & Francis, CRC Press.