CENTRAL UNIVERSITY OF SOUTH BIHAR

M.Sc. Environmental Science Syllabus

based on Choice Based Credit System (CBCS)

(Effective from Academic Session 2018-19 onwards)

Centre for Environmental Sciences

School of Earth, Biological and Environmental Sciences

Central University of South Bihar

Centre for Environmental Sciences

M.Sc. Environmental Science

Centre for Environmental Sciences, started in 2010 under the aegis of School of Earth, Biological and Environmental Sciences. The Centre is presently offering master program in Environmental Science which seeks to understand the integrated study of the earth, atmospheric, biological and chemical processes and their linkages with developmental perspectives for attaining a more sustainable environment. Students in the centre develop a holistic approach encompassing the processes, links, interactions and feedback mechanisms that operate within different environments.

The Centre of Environmental Sciences seeks to understand the integrated behaviour of the soil-plant-atmosphere; sediment-benthos- phytoplankton- zooplankton systems as it affects the flow and partitioning of resources including carbon and water. We are a highly interdisciplinary team interested in how the complex interactions between the different components of the system impact on food security and associated ecosystem services in the immediate and long-term.

We are a highly interdisciplinary team interested in how the complex interactions between the different components of the system (between and beyond disciplinary boundaries) impact on food security and associated ecosystem services in the immediate and long-term. Our approach is to underpin our research with a strong theoretical framework that is firmly imbedded in leading edge experimentation and extension program. This helps facilitate the pipeline from world-leading basic science through to application to real-world problems. The programme is designed in a way to provide necessary knowledge and skills to postgraduate students, so that they can be well-equipped to fast-track in to research leadership role and industrial application.

After successful completion of the course, the students are expected to develop the capacity to study, analyse and seek solution to environmental problems. They will also learn to analyse and asses environmental systems and problems; be able to propose sustainable solutions to environmental problems; and contribute to the development of policies and strategies for environmental planning. The major thrusts of the programme are:

1. To study issues related to exploitation of natural resources, the impacts of human activities thereon and the implications of environmental degradation on human development.
2. Natural Processes in the Environment, which focus on the natural processes such as the hydrological, atmospheric, chemical, micro-biological and ecological processes.
3. The Human Dimension of Environmental Change: to understand the determinants of the growth of populations and economies, and how this growth results in demand for natural resources, leading to scarcity, pollution and risks for human health.
4. Analytical Tools in Environmental Science: basic tools for analysing environmental problems, such as data collection and analysis and modelling of air, water, soil and biological systems.

M.Sc. Environmental Science Semester Wise Course Distribution

(Based on Choice Based Credit System (CBCS))

(Total 96 Credit, Core Course - 56 Cr., Elective Course - 40 Cr.)

Sl. No.	Course Code	Course Title	Total Credit	Theory (Cr.)	Practical/ Project/ Hands in Experience (Cr.)
Semester –I (Total credit-24)					
Core Course (Credit-20)					
1.	MSESC1001C04	Environmental Biology	4	3	1
2.	MSESC1002C04	Water Pollution: Causes, Consequences and Control	4	3	1
3.	MSESC1003C04	Environmental Chemistry	4	3	1
4.	MSESC1004C04	Environmental Geosciences	4	3	1
5.	MSESC1005C04	Field Work (Visit of Industry, Nature reserves/interpretation Centre/National Park, Protected Areas)	4	4	0
6.	----	Basic Biology*	Non credit		
7.	----	Basic Mathematics*	Non credit		
Elective Course (Credit-04)					
8.	MSESC1006E04	Introduction to Environmental Sciences	4	4	0
9.	MSESC1007E04	Social and Developmental Perspectives	4	3	1
Semester –II (Total credit-24)					
Core Course (Credit-20)					
10.	MSESC2001C04	Environmental Impact Assessment	4	3	1
11.	MSESC2002C04	Energy and Environment	4	3	1
12.	MSESC2003C04	Natural Resources and their Management	4	3	1
13.	MSESC2004C04	Air Pollution: Causes, Consequences and Control	4	3	1
14.	MSESC2005C04	Atmospheric Science & Climate Change	4	3	1
Elective Course (Credit-04)					
15.	MSESC2006E04	Analytical Methods	4	3	1
16.	MSESC2007E04	Disaster Management	4	3	1

Semester –III (Total credit-24)					
Core Course (Credit-08)					
17.	MSESC3001C04	Research Methodology	4	3	1
18.	MSESC3002C04	Dissertation	4	4	0
Elective Course (Credit-16)					
19.	MSESC3003E04	Restoration Ecology	4	3	1
20.	MSESC3004E04	The Science and Practice of Sustainable Development	4	3	1
21.	MSESC3005E04	Environmental Policies, Laws and Ethics	4	3	1
22.	MSESC3006E04	Solid Waste Management	4	3	1
23.	MSESC3007E04	Environmental Economics	4	4	0
24.	MSESC3008E04	Bio-geo chemical cycles	4	3	1
25.	MSESC3009E04	Eco-toxicology and Environmental Health	4	3	1
26.	MSESC3010E04	Environmental Modeling	4	3	1
Semester –IV (Total credit-24)					
Core Course (Credit-08)					
27.	MSESC4001C08	Dissertation	8	8	0
Elective Course (Credit-16)					
28.	MSESC4002E04	Environmental Biotechnology	4	3	1
29.	MSESC4003E04	Biodiversity and Conservation Biology	4	3	1
30.	MSESC4004E04	Microbial Ecology	4	3	1
31.	MSESC4005E04	Industrial Environment Management	4	3	1
32.	MSESC4006E04	Environmental Entrepreneurship	4	3	1
33.	MSESC4007E04	Soil Science	4	3	1
34.	MSESC4008E04	Statistical Methods and Computer Applications	4	3	1
35.	MSESC4009E04	Remote Sensing and GIS	4	3	1

List of Core courses & Elective courses of M.Sc. Environmental Science open for University Level (CUSB)

Sl. No.	Course Code	Course Title	Total Credit
Core Course			
1.	MSESC1001C04	Environmental Biology	4
2.	MSESC3001C04	Research Methodology	4
3.	MSESC1002C04	Water Pollution: Causes, Consequences and Control	4
4.	MSESC2001C04	Environmental Impact Assessment	4
5.	MSESC1003C04	Environmental Chemistry	4
6.	MSESC2003C04	Natural Resources and their Management	4
7.	MSESC2004C04	Air Pollution: Causes, Consequences and Control	4
8.	MSESC1004C04	Environmental Geosciences	4
9.	MSESC2005C04	Atmospheric Science & Climate Change	4
Elective Course			
10.	MSESC4002E04	Environmental Biotechnology	4
11.	MSESC4003E04	Biodiversity and Conservation Biology	4
12.	MSESC3003E04	Restoration Ecology	4
13.	MSESC3004E04	The Science and Practice of Sustainable Development	4
14.	MSESC4004E04	Microbial Ecology	4
15.	MSESC3005E04	Environmental Policies, Laws and Ethics	4
16.	MSESC3006E04	Solid Waste Management	4
17.	MSESC4006E04	Environmental Entrepreneurship	4
18.	MSESC3007E04	Environmental Economics	4
19.	MSESC3008E04	Bio-geo chemical cycles	4
20.	MSESC4007E04	Soil Science	4
21.	MSESC1006E04	Introduction to Environmental Sciences	4
22.	MSESC1007E04	Social and Developmental Perspectives	4
23.	MSESC3009E04	Eco-toxicology and Environmental Health	4
24.	MSESC4008E04	Statistical Methods and Computer Applications	4
25.	MSESC4009E04	Remote Sensing and GIS	4
26.	MSESC3010E04	Environmental Modelling	4
27.	MSESC2007E04	Disaster Management	4

List of Skill based courses of M.Sc. Environmental Science

Sl. No.	Course Code	Course title	Total Credit
1.	MSESC1002C04	Water Pollution: Causes, Consequences and Control	4
2.	MSESC3004E04	The Science and Practice of Sustainable Development	4
3.	MSESC3006E04	Solid Waste Management	4
4.	MSESC4005E04	Industrial Environment Management	4
5.	MSESC4006E04	Environmental Entrepreneurship	4
6.	MSESC4009E04	Remote Sensing and GIS	4

*Basic Biology / Basic Mathematics are non credit bridge courses, this will be offered to those who wish to refresh the basics of Mathematics/ Biology to cope up with the requirements of M.Sc. Environmental Sciences.

SWAYAM

20% of the total credits (96) can be earned from outside centres i.e. either SWAYAM or courses being offered within University (CUSB). These earned courses shall be booked under elective courses. The core courses are compulsory for all students admitted in M.Sc. Environmental Science programme.

The list of SWAYAM courses will be announced in the beginning of 2nd & 3rd Semester. Students may earn required credits from the prescribed list. The Centre Committee (CC) may approve, other courses also brought by students from the SWAYAM platform as the case may be.

Eligibility for open course:-

1. The student shall be enrolled in PG /masters programmes of CUSB.
2. Only for students having Bachelor of Science degree.

SEMESTER-I

Environmental Biology

Course Details			
Course Title: **Environmental Biology**			
Course Code	MSESC1001C04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 0 (T) +15 (P) Hours
Methods of Content Interaction	Lecture, Field visit, practical, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Outlines:

The Environmental Biology is focused on the natural world of animals and plants, and includes humans as a very significant species by virtue of its impact. We are living in the Age of Environmental Biology and we all need to acquire the gen of biological systems interacting with surroundings. The biological aspects of environmental science deal with ecological attributes and their evolutionary background. Each unit of this course attempts to deal about how populations and communities operate in nature.

Objectives:

- To inculcate among learners deep appreciation for various evolutionary process operating in nature.
- To highlight the effects of environmental perturbation on humans and other life forms.
- To understand interdependence and interrelationship of abiotic and biotic components of an ecosystem

Learning Outcomes

After completion of the course the learners will be able to

- Appreciate deeply about various interactions essential maintaining integrity of Ecosystem.
- Understand how our existence is dependent on all other life forms on Earth.
- Delve upon various forces of natural selection operating on every organism.

Course Contents

Unit 1. Levels of Biological Organization and Domains of ecology

Biomes-Communities-Species-Populations-Individual organisms; Correlation between structure and function at different levels of biological organization. Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones; Biodiversity and Ecosystem services

Unit 2. Population Ecology

Organismal: Adaptation and fitness, Adaptations for living in extreme environments (desert, deep sea, high altitude, hydrothermal vents). Evolution and Arms Race; Biogeographic factors affecting community diversity; Population density, dispersion and demography; Population growth- exponential and logistic models; age structured populations; Life history traits and natural selection; (r and K selection); Evolution and life history diversity; Concept of metapopulation – demes and dispersal, Density-dependent and density-independent population regulation; Global trend of human population growth

Unit 3. Community Ecology

Biological interactions: Plant-herbivore, plant-pollinator; predator-prey, competition, mutualism. Pathogens and community structure.

Biogeographic factors and biodiversity; Island equilibrium model; Global and Indian trends of biodiversity decline;

Biogeographical zones of India; Common flora and fauna in India: Aquatic: Phytoplankton, Zooplankton and Macrophytes; Terrestrial: Forests; Endangered and Threatened species.

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-15 hours	Unit 1. Levels of Biological Organization and Domains of ecology
16-30 hours	Unit 2. Population Ecology
31-45 hours	Unit 3. Community Ecology
15 Hours	*Practical and field work*

- Suggested References:

- Begon, M., Townsend R.C. & Harper, L.J. (2005) Ecology: From Individuals to Ecosystems, Wiley-Blackwell.
- Dodson, S.I. (1999) Readings in Ecology; Oxford University Press
- Ricklefs, R.E. & Miller, G. (2000) Ecology, W. H. Freeman
- Huston, M.A. (1994) Biological Diversity: The Coexistence of Species; Cambridge University Press.
- Nierenberg, W. A. (1995) Encyclopaedia of Environmental Biology, Three-Volume Set: 1-3; Academic Press
- Singh H.R. (2005) Environmental Biology; S. Chand & company Ltd. New Delhi

Water Pollution: Causes, Consequences and Control

Course Details			
Course Title: Water Pollution: Causes, Consequences and Control			
Course Code	MSESC1002C04	**Credits**	4
L + T + P	2 + 1 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	30 (L) + 15 (T) + P (15) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments, laboratory followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To learn about water pollution: sources and effects.
- To assess sources and classification of water pollutants
- To assess pollution of various water bodies.
- To learn the methods of drinking water treatment and wastewater treatment
- Basic understanding about natural waste water treatment technologies

Learning Outcomes

After completion of the course the learners will be able to:

- It will enable the students to carry out water pollution monitoring/ analysis programmes and research.
- knows the principles of mechanical and biological treatment of waste water;
- Understand meaning of important parameters for measuring water quality.
- Water quality criteria and standards, and their relation to public health, environment and urban water cycle.
- Knows the principles of natural treatment of waste water
- The student independently and in a team can do maintenance and basic design of drinking water and waste water treatment plant.
- Ability to analyze and plan Water, sanitation and hygiene programmes.

Course Contents

UNIT I – Water pollution: sources and type (12% Weightage)

Sources of water pollutants – point and non-point sources. Types of water pollutants, Organic, heavy metal, pesticides and radioactive wastes, agricultural run-off. eutrophication –causes and consequences, thermal pollution, Estuarine and marine pollution

Unit II - Concept of standards (8 % Weightage)

Drinking water and wastewater quality standards proposed by national and international agencies. Role of Government and other institutions in control of water pollution.

UNIT III- Drinking water treatment (25 % Weightage)

Potable water quality and treatment: Aerations, Coagulation and Flocculation, Sedimentation, Filtration, Disinfection, Tertiary Treatment Techniques, Recent advancements on drinking water treatment and supply

UNIT IV – Wastewater treatment (30 % Weightage)

Wastewater treatment: Wastewater characteristics - domestic wastewater characteristics, characteristics of effluents from different industries. Sewage treatment - Preliminary treatment, primary treatment, secondary treatment, tertiary treatment. Biological treatment: Biology of sewage treatment, biological growth and biological oxidation, process description of aerobic and anaerobic processes. Introduction to treatment technologies: Septic tank, Imhoff tank, oxidation ponds, Upflow anaerobic sludge blanket clarifier, Trickling filter, Rotation Biological Contactors. Natural systems for sewage treatment

UNIT V - Lab and field techniques (25 % Weightage)

Water / wastewater sampling techniques, Monitoring water pollution (Alkalinity, Hardness, Chlorides, Dissolved oxygen, Bacteriological analysis, BOD, COD, TS, MLSS, MLVSS etc.), visit of wastewater / drinking water treatment plants. Visit of lakes/ rivers to source and pollution.

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
7	**UNIT I – Water pollution: sources and type**
5	**UNIT II - Concept of standards**
15	**UNIT III- Drinking water treatment**
18	**UNIT IV – Wastewater treatment**
15	**UNIT V - Lab and field techniques**
60	**Total**

Suggested Readings:

1. Rao, C.S. (2011) Environmental pollution control engineering, New Age International Publishers, New Delhi
2. Kiely, G. (2007) Environmental Engineering, Tata McGraw-Hill, New Delhi
3. Techbanoglous, G., Burton, F.K. & Stensel, H.D. (2010) Wastewater engineering: treatment and reuse (Metcalf & Eddy, Inc.), Tata McGraw Hill, New Delhi.
4. Palmer, E. (2010) Water Pollution, Apple Academics, Canada.
5. Able P.D. (2002) Water Pollution Biology, Taylor and Francis, London.
6. CPCB / state pollution control board websites
7. Masters, G. M., & Ela, W. P. (2013). Introduction to Environmental Engineering and Science: Pearson New International Edition. Pearson Education Limited.

Environmental Chemistry

Course Details			
Course Title: Environmental Chemistry			
Course Code	MSESC1003C04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group tasks, group and individual field based assignments followed by seminar presentation.		
Assessment and Evaluation	• 35% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 50% - End Term External Examination (University Examination)		

Course Objectives

- To acquaint the students with the basic concepts related to chemical nature, processes and their interactions in the atmosphere (gaseous environment), hydrosphere (aquatic environment) and lithosphere (soil environment);
- To help the students to understand the concept of pollution in air, water and soil in relation to chemical changes in them through natural/anthropogenic factors and processes.

Learning Outcomes

After completion of the course the students will be able to:

- Understand chemistry of the atmosphere, water and soil
- Differentiate between pristine environment and impact of human activities thereon.

Course Contents

Unit 1: Principles of Environmental Chemistry: (27 % Weightage)

Gibb's free energy, Chemical potential, Chemical Equilibrium, Concept of Acid-Base, Solubility and Solubility Products, Role importance and scope of environmental chemistry, multidisciplinary nature, concept of green chemistry, Environmental transformation and degradation processes.

Unit 2: Atmospheric chemistry: (22 % Weightage)

Various segments of atmosphere & their significance, Classification, reactive intermediates in atmosphere like hydroxyl radical, ozone and nitrate radical, Acid deposition, organic pollutants, Aerosols, Smog, Ozone depletion, Black carbon in atmosphere.

Unit 3: Aquatic Chemistry: (29 % Weightage)

Chemistry of natural waters (fresh and marine), Physico-chemical properties of water, redox potential, Water pollution: Deoxygenating substances, influence of chemical process on dissolved oxygen, BOD and COD, solubility of CO_2, effect of pH, nitrogen and phosphorus transformations, salinity, eutrophication, oxygen sag curve, seasonal variations and vertical profiles of dissolved oxygen, Pesticides, heavy metals and other pollutants: transport of pollutants, bioconcentration and biomagnifications.

Unit 4: Soil Pollution and Radionuclides : (22 % Weightage)

Soil redox potential, Composition of soil, micro and macro nutrients, Sources and chemical nature of soil contaminants, organic pollutants and its fate, transport and distribution of soil contaminants, Soil – water partition process, soil microbes and organic matters.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-12	**Principles of Environmental Chemistry** Gibb's free energy, Chemical potential, Chemical Equilibrium, Concept of Acid-Base, Solubility and Solubility Products, Role importance and scope of environmental chemistry, multidisciplinary nature, concept of green chemistry, Environmental transformation and degradation processes.
13-22	**Unit 2: Atmospheric chemistry:**

	Various segments of atmosphere & their significance, Classification, reactive intermediates in atmosphere like hydroxyl radical, ozone and nitrate radical, Acid deposition, organic pollutants, Aerosols, Smog, Ozone depletion, Black carbon in atmosphere.
23-35	**Unit 3: Aquatic Chemistry:** Chemistry of natural waters (fresh and marine), Physico-chemical properties of water, redox potential, Water pollution: Deoxygenating substances, influence of chemical process on dissolved oxygen, BOD and COD, solubility of CO_2, effect of pH, nitrogen and phosphorus transformations, salinity, eutrophication, oxygen sag curve, seasonal variations and vertical profiles of dissolved oxygen, Pesticides, heavy metals and other pollutants: transport of pollutants, bioconcentration and biomagnifications
36-45	**Unit 4: Soil Pollution and Radionuclides :** Soil redox potential, Composition of soil, micro and macro nutrients, Sources and chemical nature of soil contaminants, organic pollutants and its fate, transport and distribution of soil contaminants, Soil – water partition process, soil microbes and organic matters.
15 Hours	*Practical*

Suggested Readings:

- Connell, D.W. (2005) Basic Concepts of Environmental Chemistry, CRC Press
- Manahan, S.E. (2010) Environmental Chemistry, Lewis Publishers
- Baird, C. & Cann, M. (2005) Environmental Chemistry, Freeman Publishers
- Masters, G.M. & Ela W.P. (2008) Introduction to Environmental Science and Engineering, PHI Learning, New Delhi
- Stumm, W. & Morgan, J. J. (1996) Aquatic Chemistry: chemical equilibria and rates in natural waters , Wiley Publication

Environmental Geosciences

Course Details			
Course Title: Environmental Geosciences			
Course Code	MSESC1004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The course will provide basics of geology, physical geography, oceanography and climatology

Learning Outcomes

After completion of the course the learners will be able to:

- Identification of rocks and minerals
- Geophysical techniques
- World distribution of earthquakes and volcanoes and their causes
- Mass balance of the glaciers
- Various oceanic currents
- Wind belts, high and low pressure belts, India monsoon

Course Contents

UNIT I: Geology **(40% Weightage)**

Fault, Fold, Interiors of Earth, Igneous, Sedimentary and Metamorphic rocks, rock cycle, Plate tectonics, Earthquake, Volcanic eruptions, Minerals, Geophysical techniques

UNIT II: Physical Geography (22% Weightage)

Landslide, flood, tsunami, plateau, glacier, floodplain, estuary & delta, Weathering, leaching, erosion, environmental consequences of mining

UNIT III: Climatology (26% Weightage)

Wind, and pressure system over the globe, Monsoon, Jet Stream, Western Disturbance Seasons in India

UNIT IV Oceanography (11% Weightage)

Distribution of temperature, density and salinity, ocean currents and gyres, thermohaline circulation

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-18	Fault, Fold, Interiors of Earth, Igneous, Sedimentary and Metamorphic rocks, rock cycle, Plate tectonics, Earthquake, Volcanic eruptions, Minerals, Geophysical techniques
19-28	Landslide, flood, tsunami, plateau, glacier, floodplain, estuary & delta. Weathering, leaching, erosion, environmental consequences of mining
29-40	Wind, and pressure system over the globe, Monsoon, Jet Stream, Western Disturbance Seasons in India
41-45	Distribution of temperature, density and salinity, ocean currents and gyres, thermohaline circulation
15 Hours	Tutorials

Suggested References:

- Bell, F.G. E. & Spon, F. N. (1999) Geological Hazards: Their Assessment, Avoidance and Mitigation. Books der ULB Darmstadt.
- Keller, E.A. (2007) Introduction to Environmental Geology, Prentice-Hall
- Merritts, D., De Wet, A., & Menking, K. (1997) Environmental Geology: An Earth System Science Approach, W. H. Freeman, San Francisco.
- Skinner, B. J. & Porter, S.C. (1995) The Blue Planet: An Introduction to Earth System Science, John Wiley & Sons, Inc.
- LaMoreaux, P.E. et. al. (2012) Environmental hydrogeology, CRC Press.
- Bharucha, E. (2005) Text book of environmental studies for undergraduate course, Universities Pres.
- Botkin, D. B. & Keller, E. A. (2004) Environmental Science: earth as a living planet, John Wiely & sons, New York.
- Chiras, D.D. (2012) Environmental Science, Jones & Bartlett Learning
- Mukerjee, P.K. (2006) A textbook of geology, World Press
- Climatology, D. S. Lal, Sharda Pustak Bhawan

Introduction to Environmental Sciences

Course Details			
Course Title: : Introduction to Environmental Sciences			
Course Code	MSESC1006E04	**Credits**	4
L	4	**Course Duration**	One Semester
Semester	even	**Contact Hours**	60 Hours
Methods of Content Interaction	Lecture, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand the basic concepts of environmental science and its relation with other branches
- To understand the role of different environment segment and their evolution
- To evaluate to understand the different ecosystems in biosphere
- To understand the impact of climate change in environment

Learning Outcomes

After completion of the course the learners will be able to:

- Understand about the environmental science subject and its role in our surrounding.
- Relationship between living and non-living being in our environment
- Know about different ecosystems and their role in environment

Course Contents

Unit 1 - Human activities and environmental problems, Ecology as the basic science of environmental sciences. (7% weightage)

Unit 2 - Segments of environment: Atmosphere, Lithosphere, Hydrosphere, Biosphere, and their linkages (7% weightage)

Unit 3 - Atmosphere and climate: Evolution of atmosphere, (pressure- temperature interactions)-radiation, winds, precipitation, monsoons, temperature inversions, wind energy etc.(7% weightage)

Unit 4 - Lithosphere: Earth system processes, Major land formations, Soils, Resources (minerals, metals, energy (fossil fuels, geothermal energy) (7% weightage)

Unit 5 - Hydrosphere: Oceans and freshwater sources, hydrological cycle (7% weightage)

Unit 6 - Biosphere: Major Biomes and ecosystems. (9% weightage)

Unit 7 - Ecosystem Structure and Function- Abiotic and biotic factors, Food chains and food webs. Energy transfer (photosynthesis, primary production, ecological efficiencies) Materials cycling(Carbon and Nitrogen cycles) Ecological succession (15% weightage)

Unit 8 - Climate change: global warming, ozone depletion, acid rain. Air pollution and health hazards. Water pollution (organic, pesticide, heavy metal, radioactive) and health hazards. (14% weightage)

Unit 9 - Land use patterns: effects of habitat loss or fragmentation on biodiversity. (8% weightage)

Unit 10 - Energy- generation and utilization, Urban ecosystems (waste disposal etc.) (6% weightage)

Unit 11 - Social issues: Sustainable Development, Recent trends of Environmental Science towards sustainable Development (13% weightage)

Content Interaction Plan:

Lecture cum Discussion hours	**Unit**
1-6	Human activities and environmental problems, Ecology as the basic science of environmental sciences.
7-13	Segments of environment: Atmosphere, Lithosphere, Hydrosphere, Biosphere, and their linkages
14-18	Atmosphere and climate: Evolution of atmosphere, (pressure- temperature interactions)-radiation, winds, precipitation, monsoons, temperature inversions, wind energy etc.
19-26	Lithosphere: Earth system processes, Major land formations, Soils, Resources (minerals, metals, energy (fossil fuels, geothermal energy)
27-31	Hydrosphere: Oceans and freshwater sources, hydrological cycle
32-37	Biosphere: Major Biomes and ecosystems.

38-45	Ecosystem Structure and Function- Abiotic and biotic factors, Food chains and food webs. Energy transfer (photosynthesis, primary production, ecological efficiencies) Materials cycling(Carbon and Nitrogen cycles) Ecological succession
46-50	Climate change: global warming, ozone depletion, acid rain. Air pollution and health hazards. Water pollution (organic, pesticide, heavy metal, radioactive) and health hazards.
51-53	Land use patterns: effects of habitat loss or fragmentation on biodiversity.
54-56	Energy- generation and utilization, Urban ecosystems (waste disposal etc.)
57-60	Social issues: Sustainable Development, Recent trends of Environmental Science towards sustainable Development

Suggested References:

- Miller, G.T. Jr. (2004) Environmental Science Working with the Earth, Thomson Brooks/Cole Publ. (International Students Edition).
- Miller, G.T. Jr. & Spoolman, S. E. (2010) Environmental Science, Cenage Learning.
- Singh, J.S., Singh, S.P. & Gupta, S.R. (2007) Ecology, Environment & Resource Conservation, Anamaya Publishers, New Delhi.
- Rajagopalan, R. (2005) Environmental Studies From Crisis to Cure, Oxford University Press, New Delhi
- Rangarajan, M. (ed.) (2007) Environmental issues in India A Reader, Dorling Kindersley, Delhi.
- Marten, G. (2001) Human Ecology- Basic Concepts for Sustainable Development, Earthscan Publications, UK.
- Botkin, D. B. & Keller, E. A. (2002) Environmental Science: earth as a living planet, John Wiely & sons, New York.
- Smith, T. M. & Smith, R.L. (2008) Elements of Ecology, Pearson, New Delhi.
- Odum, E. P. & Gary, B. W. (2004) Fundamentals of Ecology, Cengage Learing, USA.

Social and Developmental Perspectives

Course Details			
Course Title: : Social and Developmental Perspectives			
Course Code	MSESC1007E04	**Credits**	4
L +P	3+1	**Course Duration**	One Semester
Semester	odd	**Contact Hours**	45+15 Hours
Methods of Content Interaction	Lecture, Group discussion,field survey; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand the human and environment relationship
- Consequences towards the environment due human activities
- To understand the social crisis and issues
- To introduce students to the legal, economic, social, administrative and technical process of preparing and/or evaluating environmental impact documents.
- To relate the uses of scientific research to practical situations in project planning and decision making

Learning Outcomes

After completion of the course the learners will be able to:

- Aesthetic and relation towards the environment for conservation
- Understand main causes of social crime, events and solution
- Fully participate in interdisciplinary environmental report preparation teams.
- Analyze proposed development project plans for possible environmental effects and prepare appropriate initial studies Acquiring a better understanding of theoretical ideas in a broad and general way the ecology of human societies and the social impact of development on communities and regions.

Course Contents

Unit 1 - Human-Environment linkages: Human dependence on environment for sustenance, Resource use pattern: access and appropriation, carrying capacity, Common property resources: community management. (19% weightage)

Unit 2 - Environment and Development: Conceptualizing man-environment relationship, Environmental philosophies, Environmental movements, Concept of sustainable development, Urbanization and environment : the urban ecology concept, Large scale projects and environmental issues, Resettlement and Rehabilitation of displaced communities.(25% weightage)

Unit 3 - Poverty, famine and drought, Population and environment, Traditional communities and livelihood, Use of natural resources – Sustenance vs. commercial exploitation (15% weightage)

Unit 4 - Role and scope of Social Impact Assessment (SIA), type of social impact, principles, procedure and methods to mitigate social impacts, Benefit of SIA (17% weightage)

Unit 5 - Ecological foot prints, biocapacity, global footprint network, Globalization and consumerism (15% weightage)

Unit 6 - Role of Media in society for Environmental development, Ethic towards the sustainable development of Society (9% weightage)

Content Interaction Plan:

Lecture cum Discussion hours	**Unit**
1-10	Human-Environment linkages: Human dependence on environment for sustenance, Resource use pattern: access and appropriation, carrying capacity, Common property resources: community management.
11-22	Environment and Development: Conceptualizing man-environment relationship, Environmental philosophies, Environmental movements, Concept of sustainable development, Urbanization and environment : the urban ecology concept, Large scale projects and environmental issues, Resettlement and Rehabilitation of displaced communities.
23-28	Poverty, famine and drought, Population and environment, Traditional communities and livelihood, Use of natural resources – Sustenance vs. commercial exploitation

29-35	Role and scope of Social Impact Assessment (SIA), type of social impact, principles, procedure and methods to mitigate social impacts, Benefit of SIA
36-39	Ecological foot prints, biocapacity, global footprint network, Globalization and consumerism
40-45	Role of Media in society for Environmental development, Ethic towards the sustainable development of Society
15 hours	Monitoring and assessment of social related issues

Suggested References:

- Chris, M. (1999) Ecological Diversity in Sustainable Development, Lewis Publisher.
- Giddens, A. (2009) The Politics of Climate Change. Polity Press.
- Peter, H. (2009) A companion to Environmental Thought, Rawat Publishers.
- Bapat, J. (2005) Development Projects and Critical Theory of Development, Sage
- Bardhan, P. (2003) Poverty , Agrarian Structure and Political Economy in India, Selected Essays, Oxford University Press.
- Robbins, P. (2004) Political Ecology-A critical Introduction, Blackwell Publishing.
- Guha, R., Martinez, J. A. (1998) Varieties of Environmentalism, Oxford University Press.
- Gadgil, M. (1993) This Fissured Land ; An Ecological History of India, University of California Press
- Guha, R. (2006) The Ramachandra Guha Omnibus The Unquiet Woods, Environmentalism, Savaging the Civilized , Oxford University Press.
- Earthscan Publications, UK.

SEMESTER - II

Environmental Impact Assessment

Course Details			
Course Title: Environmental Impact Assessment			
Course Code	MSESC2001C04	**Credits**	4
L + T + P	2 + 1 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	30 (L) + 15 (T) + P (15) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments, laboratory followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To learn application value of the theory and practice of EIA
- To learn impacts caused by human interventions on the multiple dimensions of environment and means of regulating them.
- To know formats of EIA Report (Environmental Impact Statement, or Environmental Statement).
- To Understand screening, scoping and environmental clearance processes of developmental projects.
- To learn concept of CIA & RA

Learning Outcomes

After completion of the course the learners will be able to:

- Communicate both orally and in written form the key aspects of environmental impact assessment
- Discuss the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment
- Explain the major principles of environmental impact assessment
- Follow the different steps within environmental impact assessment in India
- To plan environmental impact assessment in a team
- Assess different case studies/examples of EIA in practice

Course Contents

Unit I- Introduction to Environmental Impact Assessment (8% Weightage)

Aims and objectives of Environmental Impact Assessment (EIA), EIA & Sustainability Types of EAs and examples of applications (Strategic Environmental Assessment, Social Impact Assessment, Health Impact Assessment)

UNIT II- EIA Procedure & establishing baseline conditions (15 % Weightage)

EIA Procedure, Screening, Scoping, TOR for Different Projects, Environmental Baseline and Prediction & Assessment of Impacts - on the land, air, water, and socio-economic environments.

UNIT III - EIA Methodologies (22 % Weightage)

Methods for Impact Identification: Interaction-Matrix (Simple and stepped matrices), Checklists (simple and descriptive checklists), Networks and overlays methods, Cumulative Impact Assessment, Risk Assessment, Cost Benefit Analysis

UNIT IV - Public Involvement in EIA (20 % Weightage)

What is public involvement? Identification of stakeholders, objectives of public participation Principles of public involvement, public participation techniques – Public hearing, advantages and disadvantages.

UNIT V - Legal, Policy & Regulatory framework (20 % Weightage)

Regulatory Framework for EIA: EIA notifications, Contents of EIA repot, Procedure for reviewing and EIA Report and environmental clearance.

UNIT VI - Lab and Field Skills (15 % Weightage)

Skills for baseline data generation on Air, water and Socioeconomic environment (plotting wind rose diagram, analysing water discharge and flow velocities, air / stack monitoring techniques), field visits, mock public hearings, EIA Case Studies

Content Interaction Plan:

Lecture / Discussion /Evaluation /tutorial (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
6	**Unit I- Introduction to Environmental Impact Assessment**
9	**UNIT II- EIA Procedure & establishing baseline conditions**
15	**UNIT III - EIA Methodologies**
12	**UNIT IV - Public Involvement in EIA**
12	**UNIT V - Legal, Policy & Regulatory framework**
12	**UNIT VI Lab and Field skills**
66	**Total**

Suggested Readings:

1. Anjaneyulu, Y. (2007) Environmental Impact Assessment Methodologies, B.S. Publication, Sultan Bazar, Hyderabad.
2. Glasson, J., Therivel, R. & Chadwick, A. (2012) Introduction to environmental impact assessment, Routledge, London
3. Canter, L.W. (1996) Environmental Impact Assessment McGraw Hill Publishers, New Delhi.
4. Ramachandra, T.V. (2006) Cumulative environmental impact assessment, Nova Science Publishers
5. Morgan, R. K. (2002) Environmental impact assessment: a methodological perspective, Kluwer Academic Publishers, Dordrecht
6. Eccleston, C.H. (2011) Environmental impact assessment: a guide to best professional practices CRC Press, Boca Raton
7. CPCB / state pollution control board websites
8. Masters, G. M., & Ela, W. P. (2013). Introduction to Environmental Engineering and Science: Pearson New International Edition. Pearson Education Limited.

Energy and Environment

Course Details			
Course Title: Energy and Environment			
Course Code	MSESC2002C04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group tasks, group and individual field based assignments followed by seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course focuses on various energy resources (Renewable and Non-Renewable Resources).
- It will help students to understand the science and technology of energy generation and its optimum utilization and policy initiatives.

Learning Outcomes

The students will also able to understand the linkages between energy and environment.

Course Contents

Unit 1: Energy: concept, definition, forms of energy, different sources of energy. **(9 % Weightage**

Unit 2: Laws of thermodynamics; Carnot engine; Heat pump; Patterns of Energy acquisition and utilization in living systems. **(18 % Weightage)**

Unit 3: Energy resources (Non-renewable/Conventional): Fossil fuels: coal, lignite, oil and natural gas; Thermal Power, Hydro power. **(18 % Weightage)**

Unit 4: Principle of different cycle: Rankine cycle, Brayton Cycle. Combined cycle. Co-Generation etc. **(18 % Weightage)**

Unit 5: Energy resources (Renewable/ non-conventional): Biomass, biogas, bio-fuels, solar (Flat plate collectors, solar ponds), tidal, geothermal, wind, Nuclear energy (Fission and fusion), Nuclear fuels – mining and processing of Uranium, OTEC **(27 % Weightage)**

Unit 6: Status of energy resources, Environmental consequences of energy generation (Fly ash, Nuclear wastes), Energy Policy of India, Energy audit, Optimization of energy **(10 % Weightage)**

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Unit 1: Energy: concept, definition, forms of energy, different sources of energy.
5-12	Unit 2: Laws of thermodynamics; Carnot engine; Heat pump; Patterns of Energy acquisition and utilization in living systems.
13-20	Unit 3: Energy resources (Non-renewable/Conventional): Fossil fuels: coal, lignite, oil and natural gas; Thermal Power, Hydro power.
21-28	Unit 4: Principle of different cycle: Rankine cycle, Brayton Cycle. Combined cycle. Co-Generation etc.
29-40	Unit 5: Energy resources (Renewable/ non-conventional): Biomass, biogas, bio-fuels, solar (Flat plate collectors, solar ponds), tidal, geothermal, wind, Nuclear energy (Fission and fusion), Nuclear fuels – mining and processing of Uranium, OTEC,
41-15	Unit 6: Status of energy resources, Environmental consequences of energy generation (Fly ash, Nuclear wastes), Energy Policy of India, Energy audit, Optimization of energy
15 Hours	*Practical*

Suggested Readings:

- Fay, J.A. & Golomb, D.S. (2011). Energy and the Environment: Oxford university press.
- Rai, G.D. (2010) Non-conventional sources of energy: a textbook for engineering student, Khanna Publisher, Delhi
- Tiwari, G.N. & Ghosal, M.K. (2005). Renewable Energy Resources: Basic Principles and Applications, Alpha Science International Limited

- Abbasi, T. & Abbasi, S.A. (2006) Renewable Energy Sources and their Environmental Impact, PHI Learning Pvt. Ltd
- Kaushika, N.D. & Kaushik, K. (2004) Energy, ecology and environment: a technological approach, Capital Publications, New Delhi

Natural Resources and their Management

Course Details			
Course Title:	**Natural Resources and their Management**		
Course Code	MSESC2003C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Practical, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand deeply about the naturally available common resources.
- To highlights on natural resources including forests, wildlife, minerals and water.
- To provide basic understanding of distribution, utilization, conservation and management of natural resources at local, national, and global scales
- To understand the historical importance of natural resources in the economic development
- To understand the impact of changes in lifestyles and the economic base of the region and implications for land management
- To develop an appreciation for the ecological diversity of the region and its sustainable management.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand about the different natural resources available in our surrounding
- understand the distribution and availability of economic benefit resources
- plan for the environmental resource management in sustainable management
- proper planning of land use management
- safeguard the resources avoiding huge impact due to anthropogenic activities

- Substantial knowledge about various methodological and analytic approaches that may be useful for conservation of resources.

Course Contents

Unit 1 - Water Resources: (32% weightage)

Global water budget, Surface and groundwater, Marine and freshwater resources, Glacier, Rainwater harvesting, Watershed management, Concept of groundwater hydrology and management. Human influences on water resources, planning for water resource management (Government scheme, National water policy), Food and other natural resources, Natural resources from ocean.

Unit 2 - Forest and Wildlife Resources: (33% weightage)

Forest types, role of forest, forest products, Tribal and forest, Administrative classification of forest, Social forestry, Community forest, Indian forest policy, Methods of forest conservation, Human impact on forest.

Wildlife resources and its importance, Wildlife conservation methods, restoration of wildlife, Habitat management, National parks and Sanctuary, Engendered species of India, Ecotourism, Human influence on wildlife.

Unit 3 - Soil/Land and Minerals Resources (35% weightage)

Land forms and classification, Land use pattern, Land use planning, Land degradation causes and its effect, Desertification, Saline intrusion

Soil classification, methods of soil conservation.

Minerals and ore, classification of minerals, Status and distribution of mineral resources (global and Indian context), Mineral resource development and exploitation, conservation and management of minerals

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-15 hours	Unit 1.Water Resources:
16-35 hours	Unit 2.Forest and Wildlife Resources:

36-45 hours	Unit 3.Soil/Land and Minerals Resources
15 Hours	*Practical, field work, report*

- Suggested References:

- Knight, L., Richard, et. al. (ed.) (1995). A New Century for Natural Resources Management. Island Press.
- Cech, T. (2002) Principles of water resources: History, development management and policy, Wiley, UK,
- Shiferaw, B., Freeman, H.A., & Swinton, S.M. (2004) Natural resource management in agriculture: Methods for assessing economic and environmental impacts, CAB eBooks
- Bhattacharya, P., Kandya, A.K. & Kumar, K. (2008). Joint Forest Management in India, Aavishkar Publisher, Jaipur.
- Bonell, M., Bruijnzee, L.A. (2005). Forests, Water and People in the Humid Tropics: Past, Present and Future Hydrological research for integrated land and water management Cambridge University Press.
- Aswathanarayana, U. (2003). Mineral Resources Management and the Environment. Taylor & Francis.

Air Pollution: Causes, Consequences and Control

Course Details			
Course Title: :	**Air Pollution: Causes, Consequences and Control**		
Course Code	MSESC2004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, practical, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand the basic concepts of air pollution and its types
- To evaluate the sources and causes of air pollution
- To assess the impacts of air pollution in health and surrounding
- To understand the analysis techniques of different air pollutants
- To evaluate the control technique of air pollutants before emission from any source points

Learning Outcomes

After completion of the course the learners will be able to:

- Understand the sources of air pollutants from different air pollution.
- Assess the toxic air pollutants and its role in environment
- Could evaluate the health risk factors
- Expertise in different instrumental methods to analyze the different air pollutants.
- Understand the air pollution control technique

Course Contents

Unit 1 - Air Pollution: (18% weightage)

An introduction to air pollution, Naturally occurring air pollutants, generation of air pollutants, units and estimation of pollutant concentration, National Ambient Air Quality Standards, Vehicular Emission norms, Classification of Pollutants, primary and secondary pollutants, stationary and mobile sources, Photochemical smog and Sulphurous smog. Urban heat island

Unit 2 - Air pollution Meteorology: (17% weightage)

Atmospheric stability, Lapse rates, dispersion of air pollutants in the atmosphere, impact of wind on dispersion of pollutants, Diffusion and transport of pollutants, wind roses, Air pollution models and their equations

Unit 3 - Air quality monitoring: (14% weightage)

Ambient air quality measurement, Sampling and analysis of gaseous pollutants (chemical and analytical methods), Sampling and analysis of Particulate Matter (ambient and Stack monitoring). High Volume Samplers. Biomonitoring of air quality.

Unit 4 - Indoor air quality: (9% weightage)

Causes and sources of indoor air quality problems, risk due to indoor air pollutants, indoor air quality controls

Unit 5 - Air pollution control: (20% weightage)

General principles of air pollution control, Particulate matter control equipments: Gravity Settling Chambers, Wet collectors, Electrostatic precipitator, Cyclone collectors, Bag House Filters. Control of gaseous emissions, absorption by liquids, adsorption by solids, Control of SOx, NOx, CO, Hydrocarbons & other pollutants, GHG emission monitoring.

Unit 6 - Impacts of air pollutants: (10% weightage)

On microorganisms, plants, animals and humans.

Unit 7 - Noise pollution: (12% weightage)

Definition and sources, measurement of noise and sound pressure level, impact of noise on human health, noise control and abatement measures

Content Interaction Plan:

Lecture cum Discussion hours	**Unit**
1-6	Unit 1.Air Pollution
7-12	Unit 2. Air pollution Meteorology
13-17	Unit 3. Air quality monitoring
18-22	Unit 4. Indoor air quality
23-33	Unit 5. Air pollution control
34-40	Unit 6.Impacts of air pollutants
41-45	Unit 7.Noise pollution
15 Hours	*Lab.Practical/field experiment*

Suggested References:

- Masters, G. (1991) Introduction to Environmental Engineering, Prentice Hall
- *Peavy*, H.S., *Rowe,* D.R., & Tchobanoglous, G. (*1985*) Environmental Engineering, McGraw Hill
- Rao, C.S. (2007) Environmental Pollution & Control, New Age international (P) Ltd.
- Khopkar, S.M. (2004) Environmental Pollution Monitoring and Control: New Age international (P) Ltd
- Jack G. Kay, George E. Keller, Jay F. Miller (1991) Indoor Air Pollution: Radon, Bioaerosols, and VOCs.CRC press Taylor & Francis group
- Richard B. Gammage (1996).Indoor air and human health (second Edition). CRC Press.

Atmospheric Science & Climate Change

Course Details			
Course Title: Atmospheric Science & Climate Change			
Course Code	MSESC2005C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

This course will help to students in developing understanding on structure and functions of atmosphere and how changes due to natural and human activities resulting in climate change.

Learning Outcomes

After completion of the course the learners will be able to:

- Understanding on structure and processes of the earth's atmosphere
- External and internal causes of the climate change
- Modelling studies of the climate change
- Basics of climate models
- Causes of extreme events
- Impact of climate change on various sectors

Course Contents

UNIT I: (31.2% Weightage)

General Circulation of atmosphere, Climate classification (Köppen & Thornthwaite), Monsoon variability, weather forecasting and climate prediction, Components of climate system, global warming and climate change

UNIT II: (22.2% Weightage)

Solar and Terrestrial radiation, radiation laws, Heat balance of the earth, Radiative forcing, Atmospheric lapse rate, dry and moist adiabatic lapse rate, Stability and instability criteria

UNIT III: **(8.9% Weightage)**

Aerosol and its role in climate change, formation of Clouds, cloud seeding

UNIT IV: **(13.3% Weightage)**

External and Internal causes of Climate Change, Feedback processes

UNIT V: **(15.5% Weightage)**

Global and Regional climate projections and associated uncertainty, Climate change and Cold/heat waves, Flood/droughts, Heavy rainfall, Tropical Cyclones, Sea Level Rise

UNIT VI: **(8.9% Weightage)**

Impact of Climate change on important sectors Agriculture, water, forest, biodiversity, health, IPCC, UNFCC

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-14	General Circulation of atmosphere, Climate classification (Köppen & Thornthwaite), Monsoon variability, weather forecasting and climate prediction, Components of climate system, global warming and climate change
15-24	Solar and Terrestrial radiation, radiation laws, Heat balance of the earth, Radiative forcing, Atmospheric lapse rate, dry and moist adiabatic lapse rate, Stability and instability criteria
25-28	Aerosol and its role in climate change, formation of Clouds, cloud seeding
29-34	External and Internal causes of Climate Change, Feedback processes
35-41	Global and Regional climate projections and associated uncertainty, Climate change and Cold/heat waves, Flood/droughts, Heavy rainfall, Tropical Cyclones, Sea Level Rise
42-45	Impact of Climate change on important sectors Agriculture, water, forest, biodiversity, health, IPCC, UNFCC
15 Hours	Tutorials

- Suggested References:

- W. D. Sellers: Physical Climatology
- Cole, F: Introduction to Meteorology
- F.W. Taylor: Elementary Climate Physics
- Trewartha: Introduction to Climates
- Lamb: Climate Present, Past and Future
- K. McGuffie, A. Henderson-Sellers: A Climate Modelling Primer, John Wiley & Sons
- C. Donald Ahrens: Meteorology Today
- IPCC (2001 & 2007) Working Group I Report "The Physical Science Basis"

Analytical Methods

Course Details			
Course Title: Analytical Methods			
Course Code	MSESC2006E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group tasks, group and individual field based assignments followed by seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce the students to a wide variety of modern analytical techniques used in environmental science research.
- The lectures focus on selected analytical facilities that are commonly used to analysis of air, soil, sediment, water etc.

Learning Outcomes

- The student will able to understand the basics principles of the major analytical methods, techniques and instrumentation which will help in environmental samples analysis and in further research.

Course Contents

Unit 1: Analytical techniques: Principles working and application of Titrirmetry, Gravimetry, High Volume Sampler and Respirable Dust Sampler, Neutron Activation Analysis (NAA), Anodic Stripping Voltametry (ASV), Theory of UV-Visible Spectroscopy & colourimetry, Beer Lambert law, Deviation from Beer Lambert law. Spectrophotometer (UV-Visible), Flame photometer, Atomic Absorption Spectrophotometer (AAS), Ion selective electrodes.

Unit 2: Advanced spectroscopy and chromatography: Principles, Working and applications of Chromatographic methods: Column chromatography, Gas Chromatograph (GC), High Performance (pressure) Liquid chromatograph (HPLC), Ion chromatograph, Different types of detectors, Gas Chromatograph-Mass spectroscopy (GC-MS), X-Ray Florescence, X-Ray diffraction, Inductively coupled plasma emission spectroscopy (ICPES), Fourier transform infrared (FTIR) Spectroscopy.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-23	**Unit 1: Analytical techniques**: Principles working and application of Titrirmetry, Gravimetry, High Volume Sampler and Respirable Dust Sampler, Neutron Activation Analysis (NAA), Anodic Stripping Voltametry (ASV), Theory of UV-Visible Spectroscopy & colourimetry, Beer Lambert law, Deviation from Beer Lambert law. Spectrophotometer (UV-Visible), Flame photometer, Atomic Absorption Spectrophotometer (AAS), Ion selective electrodes.
24-45	Unit 2: **Advanced spectroscopy and chromatography:** Principles, Working and applications of Chromatographic methods: Column chromatography, Gas Chromatograph (GC), High Performance (pressure) Liquid chromatograph (HPLC), Ion chromatograph, Different types of detectors, Gas Chromatograph-Mass spectroscopy (GC-MS), X-Ray Florescence, X-Ray diffraction, Inductively coupled plasma emission spectroscopy (ICPES), Fourier transform infrared (FTIR) Spectroscopy.
15 Hours	*Practical*

Suggested Readings:

- Baird, C. & Cann, M. (2008). Environmental Chemistry, W.H. Freeman and company
- Murphy, W.J. (1997) Analytical Chemistry, American chemical Society, USA
- Reeve, R. (2002) Introduction to Environmental Analysis, John Willey and Sons
- Chatwal, G.R. & Anand, S.K.(2007) Instrumental methods of Chemical analysis, Himalaya Publishing House, Delhi
- Skoog , D. A., Holler, F.J., & Crouch, S.R. (2006) Principles of Instrumental Analysis, Brooks Cole
- Rouessac , F. & Rouessac , A. (2007) Chemical Analysis: Modern Instrumentation Methods and Techniques, Wiley
- Day, Jr. R.A., & Underwood, A.L. (2009) Quantitative Analysis, PHI

Disaster Management

Course Details			
Course Title: Disaster Management			
Course Code	MSESC2007E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The course is focused on understanding various types of natural and man-made disaster, risk associated with them and deals with disasters management including preparedness and rehabilitation using political, administrative and social machinery.

Learning Outcomes

After completion of the course the learners will be able to:

- What are natural and man made disasters
- Basic concepts of disasters, hazard, risk, vulnerability, impact
- Preprartion and management before disasters, during disasters and after disasters
- Students may choose it as career

Course Contents

UNIT I: (35.5% Weightage)

Introduction to disaster: disaster and hazard, natural and anthropogenic disasters and their causes, Climate change and disaster
Basic Concepts: Hazard, risk, vulnerability, mitigation

UNIT II: (26.6% Weightage)

Risk Assessment and Vulnerability Analysis: Tools and techniques for risk and vulnerability,
Impacts of Disasters: Health, physical and socio-economic and others, GIS in Disaster Studies

UNIT III: (24.5% Weightage)

Disaster Management Cycle (Mitigation, Preparedness, Response and Recovery): Mitigation: Disaster Risk Reduction (DRR), The Emergency Operation Plan (EOP), **Disaster Preparedness**: Preventive measures, Early warning system, **Response and Recovery**: Disaster Response Activities, The Recovery Plan

UNIT IV: (13.4% Weightage)

Role of Media in mitigation and increasing awareness, Role of Government department of Disaster Management and Disaster Management authority

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-16	disaster and hazard, natural and anthropogenic disasters and their causes, Climate change and disaster**,** Hazard, risk, vulnerability, mitigation
17-28	Tools and techniques for risk and vulnerability, Impacts of Disaster on Health, physical and socio-economic and others, GIS in Disaster Studies
29-38	Disaster Management Cycle (Mitigation, Preparedness, Response and Recovery), Mitigation, Disaster Risk Reduction (DRR), The Emergency Operation Plan (EOP), Disaster Preparedness through Preventive measures, Early warning system, Response and Recovery through Disaster Response Activities, The Recovery Plan
39-45	Role of Media in mitigation and increasing awareness, Role of Government department of Disaster Management and Disaster Management authority
15 Hours	Tutorials

- Suggested References:
- R.B.Singh (Ed) Environmental Geography, Heritage Publishers New Delhi,1990
- Savinder Singh Environmental Geography, Prayag Pustak Bhawan, 1997
- Kates,B.I & White, G.F The Environment as Hazards, oxford, New York, 1978
- R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000
- H.K. Gupta (Ed) Disaster Management, Universiters Press, India, 2003
- Dr. Satender, Disaster Management in Hills, Concept Publishing Co., New Delhi, 2003
- A.S. Arya Action Plan For Earthquake, Disaster, Mitigation in V.K. Sharma (Ed) Disaster Management IIPA Publication New Delhi, 1994
- R.K. Bhandani An overview on Natural & Man made Disaster & their Reduction, CSIR, New Delhi
- M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001

SEMESTER – III

Research Methodology

Course Details			
Course Title: Research Methodology			
Course Code	MSESC3001C04	**Credits**	4
L + T + P	3 + 1 +0	**Course Duration**	One Semester
Semester	ODD	**Contact Hours**	30 (L) + 15 (T)+0 Hours
Methods of Content Interaction	Lecture, Proposal writing, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Outline

This subject will help students to have overview of research process. This course will also impart knowledge to identify a relevant research problem, how to survey the literature. Students will also get idea about how to make sampling design, how to analyse data and finally their better representation.

Course Objectives

- To instill research ability among learners
- To discuss best possible methods of developing a research question
- To highlight scientific methods of collection, analyses and interpretation of data.

Learning Outcomes

After completion of the course the learners will be able to:

- Do independent researches on scientifically valid research question
- Collect, analyze and interpret data
- Develop proposal,
- Write thesis and report.
- Gain substantial knowledge about various methodological and analytic approaches.

Course Contents

Unit 1. Planning of Research:

Definition, types and classification of research, Problem Definition Nature and purpose of scientific enquiry, Overview of Research process, Steps in Research Process, Basic concepts in problem identification, Relevance of the problem chosen, Review of literature, Parameters of research, Definition of construct and variables. Objectives & strategies of research,

Unit 2. Sampling Design and Experimental Method:

Implication of sampling design, Types of sample designs, Laboratory methodology, Standardization of protocol, Amendments in protocol, Definition and Types of experiment, Types of observation methods. Randomized block, Latin Square, Factorial experimental design, response surfaces. Sampling Methods: Probability sampling, random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling.

Unit 3. Processing, Analysis of Data and Thesis/ Report writing:

Types of data sources, Analysis and processing of data, Hypothesis testing, Definition and types of hypothesis, Test of significance.

Types and steps of data analysis, Software mediated processing of data, Diagrammatic and graphic presentation, Structure for a University Thesis, Structure for a research journal article, Citing of references, writing an effective synopsis. Pre writing considerations, Thesis writing, Format of report writing, Format of publications in research journals.

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-15 hours	Unit 1. **Planning of Research**
16-35 hours	**Unit 2. Sampling Design and Experimental Method**
36-45 hours	**Unit 3. Processing, Analysis of Data and Thesis/ Report writing**
15 Hours	*Tutorial, Problem development, report*

- Suggested References:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
2.. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)
3. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
4.Kumar, R. (2006) Research Methodology, Pearson
5. Kumar, C.R. (2011) Research methodology, APH Publishing Corporation
6. John W. Creswell (2003) "Research Design: Qualitative, Quantitative and Mixed Methods Approaches. SAGE Publications International Educational and Professional Publisher; New Delhi
7. Gauch, Jr. H. G. (2003):Scientific methods in practice : Cambridge Univ Press

Restoration Ecology

Course Details			
Course Title: **Restoration Ecology**			
Course Code	MSESC3003E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) +0 (P) Hours
Methods of Content Interaction	Lecture, Field visit, Tutorials, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Outlines:

Environmental degradation is often an inevitable consequence of many developmental activities. In such cases, it is desirable to restore to the extent possible the degraded ecosystems to their original state. This course highlights recent biological and biotechnological approaches to the remediation and restoration of ecosystems degraded by human activities.

Objectives:

- To inculcate among learners deep appreciation for natural self-purification ability of an ecosystem.
- To highlight the role of various ecological processes in changing a degraded ecosystem into pristine condition.
- To delve upon various methods of restoration of a degraded ecosystem

Learning Outcomes

After completion of the course the learners will be able to

- Understand causes of degradation of an ecosystem
- Restore a degraded ecosystem for human use and
- Delve upon various ecosystem services

Course Contents

Unit 1. General concepts of restoration ecology;

Causes of Ecological Degradation: Pollution and waste disposal, excess nutrient loading in aquatic ecosystems. Mining, deforestation, overgrazing, salinization and exotic species, Ecosystem services

Reference Ecosystem; Intermediate disturbance hypothesis and restoration.

Unit 2. Process of restoration;

Rehabilitation, Reclamation, Mitigation and Restoration: Methods, techniques and approaches;

Biomanipulation and lake restoration, Ecological trajectory during restoration, Attributes of restored ecosystems,

Unit 3. Maintaining restored ecosystem

Ecological engineering: Maintaining a restored ecosystem, Bioremediation and constructed wetlands

Natural versus Restored Ecosystems - limitations of restored ecosystems,

Restoration of wasteland, River restoration, Case studies,

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-15 hours	Unit 1. General concepts of restoration ecology
16-30 hours	Unit 2. Approaches of restoration
31-45 hours	Unit 3. Maintaining a restored ecosystem
15 Hours	*Tutorials and field work*

Suggested References:

1. Meffe, G.K. & Carroll, C.R. (2005) Principles of Conservation Biology, Sinauer Associates.
2. Primack, R. B. (2002) *Essentials of Conservation Biology***,** Sinauer Associates, Sunderland, Ma. USA
3. Loreau, M. & Inchausti, P. (2002). Biodiversity and ecosystem functioning: Synthesis and Perspectives, Oxford University Press, Oxford, UK.
4. Falk, D.A., et al. (2006) *Foundations of restoration ecology: the science and practice of ecological restoration*, Society for Ecological Restoration International, Tucson, Az., USA.
5. Jordan, W.R., et al. (1987) *Restoration ecology*, Cambridge University Press.
6. Andel, J. & Aronson, J. (Eds.) (2012) Restoration Ecology: The New Frontier; Wiley Blackwell

The Science and Practice of Sustainable Development

Course Details			
Course Title:	**The Science and Practice of Sustainable Development**		
Course Code	MSESC3004E04	**Credits**	4
L + T + P	2 +1 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	30 (L)+15 (T)) + 15 (P) Hours
Methods of Content Interaction	Lecture, Group discussion, Practical, report writing, self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The goal of this course is to introduce the student to the multi-dimensional aspects of sustainable development, by looking at the historical roots and dual goals of sustainable development, and then focusing on current topics to understand how they link to development theory and the discussion how sustainable development can be affected on international, national, and local levels.

The major objectives of this course are

- To underpin the origin and key concepts of sustainability and how to apply those to sustainable development practice.
- To understand the practice and policy of sustainable pathways to development.
- To highlights some of the scientific underpinnings of sustainable development practice and how policy-makers are trying to apply it for better governance of scarce resources
- To apply relevant aspects of the science and policies of sustainable development to learner's own practice as a development leader.
- To understand how various attributes of sustainability (environmental, economic and social) can be applied by development practitioners and other stakeholders

- To gain scientific knowledge regarding planetary boundaries processes and their influence on global development scenario.
- To be aware of the current international policy landscape for the Sustainable Development Goals (SDGs).

Learning Outcomes

After completion of the course the learners will be able to:

- Explore and practice the Sustainable development pathways applying theories and case studies from a range of Disciplines.
- Apply various attributes of sustainability (environmental, economic and social) for development.
- Explain the planetary boundaries, urbanization and growing inequality, and practice the integral sustainable development as their everyday existence.
- Bridge the science and the practice of the application and enhancement of sustainable development.
- Address the world's most urgent challenges, with emphasis on the linkages between science and policy.

Course Contents

Unit 1. Sustainable development: (32% weightage)

Development and its impacts on our environment. Various global and local environmental issues. Interdependence of man and environment. Biodiversity linkages and human existence. Definition and scope of sustainable development. Introduction and History: Brundtland, Rio, SDGs; Basic Concepts, Strategies and Measurement. The future of sustainable development requires a global approach. Strength and weaknesses of the United Nation's Sustainable Development Goals (SDGs).

UNIT II. Drivers of inequality: Global distribution of poverty and natural resources, ending extreme poverty;

Strategies for addressing extreme poverty and the impact of the Millennium Development Goals. Food and water security, Sustainable global food supply and sustainable development. Human Rights and Gender Equality ; Introduction to the challenges around equality, equity and fairness to all.

Introduction to a life-cycle approach, and the, role of education in sustainable development. Education, primary health care systems and poverty. The interaction between the environment and human health.

UNIT III. Efficiency and Innovation, Green Growth and Rebound

Introduction to the influence of increasing urbanisation. Sustainable Cities; Methods of developing sustainable cities. Planetary Boundaries: Planetary boundaries and development. Growth within Planetary Boundaries, Sustainable growth within the planetary boundaries.

Climate Change and Biodiversity: Introduction to the science of climate change, Mitigation of climate change effects. Saving Biodiversity Exploration of the threats to biodiversity, from oceans to forests, and the need for international cooperation.

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-15 hours	**Unit I. Sustainable development**: (32% weightage)
16-35 hours	**Unit II. Drivers of inequality**
36-45 hours	**Unit III. Efficiency and Innovation, Green Growth and Rebound**
15 Hours	*Practical, field work, report*

Suggested References:

- **An Introduction To Sustainable Development 2nd Edition (English, Paperback, Peter P. Rogers);** Earthscan Publications; ISBN: 9781844075201, 1844075206. 2nd Edition, 2007;
- **Sustainable Development (English, Hardback, Baker Susan);** Published by Taylor and Francis; SBN: 9780415522915, 0415522919; Pages: 450.
- Economic Growth and Sustainable Development (English, Paperback / softback, Hess Peter N); Published by Taylor and Francis; Pages: 720.
- Buchholtz, Ann K. / Carroll, Archie B. (2009): Business & Society, 7th ed., (SouthWestern, Cengage)
- Hoffmann, A. J. / Woody, J. G. (2008): Climate Change: What's Your Business Strategy? Boston, MA (Harvard Business School Publishing).
- Bishop Peter, Hines Andy and Collins Terry, "The current state of scenario development: an overview of techniques" in Foresight, Volume 9, Issue 1, 2007, Page: 5–25.
- Austin, James and Tomas Kohn. 1990. Strategic Management in Developing Countries. The Free Press.

Environmental Policies, Laws and Ethics

Course Details			
Course Title: Environmental Policies, Laws and Ethics			
Course Code	MSESC3005E04	**Credits**	4
L + T	3 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	40 (L) + 20 (T)
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments, laboratory followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To know the need of legal/legislative measures for mitigating environmental problems.
- To get aware the students about current environmental laws and policies of India and to understand the historical and cultural roots of environmental ethics
- To explain the role of law, policy and institutions in the conservation and management of natural resources as well as pollution control
- To introduce the international conventions laws and policies relating to environment
- To equip the students with the skills needed for interpreting laws, policies and judicial decisions

Learning Outcomes

After completion of the course the learners will be able to:

- be familiar with the laws, policies and institutions in the field of environment in India
- Understand the legal compliance of environmental laws in various sector.
- acquire the skills needed for interpreting laws, policies and judicial decisions in the field of environment.
- Familiar with multilateral environmental agreements and role of international institutions.

Course Contents

UNIT I – Foundations of Environmental Law and ethics (20% Weightage)

Need for policies and laws, changing bases of environmental protection. An introduction to the legal system; Constitution, Acts, Rules, PIL, Constitutional provisions for protection of environment, Duty of state and citizen for environmental protection in India, Right to wholesome environment, ethics for environmental conservation, biocentric and ecocentric theory, ecofeminism, deep ecology and sustainable use of resources. Case studies.

Unit II – Environmental conventions and multilateral agreements (20 % Weightage)

International convention for protection of environment: Stockholm declaration, Ramsar convention on wetlands, Vienna convention & Montreal Protocol, Kyoto Protocol, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention to Combat Desertification (CCD), Convention on Biological Diversity (CBD), recent conventions related to climate change. Role of International institutions (IUCN, UNEP, WHO, UNESCO, etc.)

UNIT III- Water and Air laws (25 % Weightage)

India's water policy, Control of water pollution and law, Water Act 1974, Objectives of water act, definition and meaning of water pollution, Constitution of Central and State pollution control Boards, Power and functions of the boards for prevention and control of water pollution. Offences and penalties. Air Act 1981, definition and meaning of air pollution, Role, Power and functions of the boards for prevention and control of air pollution, Offences and penalties. Water Cess Act 1977

UNIT IV – Environment Protection and waste disposal laws (20 % Weightage)

Legal framework on environment protection, EPA 1986, object and the reasons of the law, powers and functions of the central government, offences and penalties. Solid Waste Management Rules, 2016, Bio-Medical Waste Management Rules, 2016, Plastic Waste Management Rules, 2016, E-Waste (Management) Rules, 2016.

UNIT V - –Forest and Wildlife related laws (15 % Weightage)

National forest policy, Forest conservation Act, Indian Forest Act, Compensatory Afforestation, Wildlife protection Act

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
6	UNIT I – Foundations of Environmental Law and ethics
8	Unit II – Environmental conventions and multilateral agreements
10	UNIT III- Water and Air laws
10	UNIT IV – Environment Protection and waste disposal laws
6	UNIT V - –Forest and Wildlife related laws
40	Total
20	Tutorial

Suggested Readings:

1. Divan, S. & Rosencranz, A. (2008) Environmental law and policy in India, New Delhi Oxford University Press.
2. Bhat, S. (2010) Natural Resources conservation law Sage Publishers, New Delhi
3. Jamieson, D. (2008) Ethics and the Environment: An Introduction, Cambridge University Press.
4. Leelakrishnan, P. & Wadhwa, B.(2008) Environmental law in India by Publishers, New Delhi
5. Desai, B. (2010) Multilateral Environmental Agreements: Legal Status of the Secretariats Cambridge University Press
6. Website of International Institutions, MoEF&CC, CPCB, SPCBs

SOLID WASTE MANAGEMENT

Course Details			
Course Title: Solid Waste Management			
Course Code	MSESC3006E04	**Credits**	4
L + T +P (project)	2+1+1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	30 (L) + 10 (T) +20(P)
Methods of Content Interaction	Project based learning process; Lecture, Tutorials, Group discussion; Case study, seminar, presentations by students, group and individual field based assignments,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To Understand of problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc.
- To understand the solid waste management aspects and disposal techniques.
- To understand the role of institutions and regulatory requirements.
- To enable students to understand of the concept of Waste Management, Minimization and Utilization.

Learning Outcomes

After completion of the course the learners will be able to:

- Do sampling and characterization of solid waste;
- Understand the implementation of various aspects of waste management, minimization and utilization.
- Apply the knowledge in industries and urban planning.

Course Contents

UNIT I – Solid wastes introduction (20 % Weightage)
Types and Sources, Present scenarios of municipal and industrial waste management in India, Health and environmental issues related to solid waste.

UNIT II – Solid waste properties (15% Weightage)
Characteristics, classification, waste generation rates, factors affecting waste generation rates, Sampling and characterization of solid waste, Project work and case study.

Unit III – Functional elements of solid waste management (15 % Weightage)
Design specifications of primary waste collection tools, waste storage bins, transportation vehicles, route selection and provision of transfer stations.

UNIT IV- Methods of waste reduction (15 % Weightage)
Material and resource recovery/recycling from solid wastes, Waste reduction at source – municipal and industrial wastes, Segregation, reuse, recycle, neutralization, equalization

UNIT V- Waste management and disposal options (10 % Weightage)
Sanitary Land filling- site selection, rapid EIA of proposed sites, Method of preparing sanitary landfill site, land filling techniques, operation and maintenance of landfill sites including leachate collection, treatment, and design), Thermal treatment of waste - Incineration, Pyrolysis, plasma technology, advantages and limitations of thermal treatment,
Composting - Aerobic composting, Anaerobic composting, vermi-composting, advantages and limitations of composting technologies

UNIT VI- Hazardous waste management (25 % Weightage)
Hazardous waste management- definition and classification, treatment technologies, Biomedical, Electronics, Industrial waste and their management.

UNIT VII - Institutional aspects and regulatory requirements
Institutional aspects and private sector participation for Solid Waste Management, institutional deficiencies, Swachh Bharat Mission. Regulatory requirements for waste management in India

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
3	**UNIT I – Solid wastes introduction**
6	**UNIT II – Solid waste properties**
6	**Unit III – Functional elements of solid waste management**
3	**UNIT IV- Methods of waste reduction**
7	**UNIT V- Waste management and disposal options**
3	**UNIT VI- Hazardous waste management**
2	**UNIT VII Institutional aspects and regulatory requirements**
30	**Total**
10	**Tutorial**
20	**Field and project**

Suggested Readings:

1. Masters, G.M. (2008) Introduction to environmental engineering and science, Prentice Hall
2. Khan, I.H. & Ahsan, N. (2003) Textbook of solid wastes management, CBS Publishers, New Delhi
3. Tchobanoglous, G. (2002) Handbook of solid waste management, McGraw-Hill, New York.
4. Cheremisinoff, N.P. (2002) Handbook of solid waste management and waste minimization technologies, Elsevier, Woburn
5. Zhu, Da, Asnani, P. U., Zurbrügg, C., Anapolsky, S. and Shyamala, M. (2008) Improving Municipal Solid Waste Management in India, The World Bank
6. Manual on Municipal Solid Waste Management (2000) Central Public Health and Environmental engineering Organization, Ministry of Urban Development, Govt. of India.

ENVIRONMENTAL ECONOMICS

Course Details			
Course Title: Environmental Economics			
Course Code	MSESC3007E04	**Credits**	4
L + T +P (project)	2+1+1	**Course Duration**	One Semester
Semester		**Contact Hours**	30 (L) + 10 (T) +20(P)
Methods of Content Interaction	Project based learning process; Lecture, Tutorials, Group discussion; Case study, seminar, presentations by students, group and individual field based assignments,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course helps the student to apply economic concepts and theories to conservation and sustainable utilization of natural resources.
- To equip students to apply tools of environmental economics in resolving business problems

Learning Outcomes

After completion of the course the learners will be able to:

- Understand how economic tools can be used to solve environmental problems
- Understand the economic valuation and conservation.

Course Contents

UNIT I – Introduction to Environmental Economics (20 % Weightage)

Environmental Economics – Basic principles, Economy and Environment, Introduction to Environmental Economics, Economic and environmental values, Concept of Supply and Demand; Producer and Consumer Surplus

UNIT II –Economic Analysis Tools (20% Weightage)

Tragedy of the Commons, public goods and property rights, externalities, types of externalities, solutions to externalities, market failures

Unit III – Valuing environment (20 % Weightage)

Economic valuation methods - Techniques for valuation, case studies, Cost-Benefit Analysis, discounting, environmental accounting.

UNIT IV- Trade and environment (20 % Weightage)

Concept of sustainable development, climate change, carbon trading and clean development mechanism, Global environmental issues.

UNIT V- Controlling environmental problems through economic tools (20 % Weightage)

Command and control policies, polluter pay principle, fees and subsidies, compliances.

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-8	**UNIT I – Introduction to Environmental Economics** Environmental Economics – Basic principles, Economy and Environment, Introduction to Environmental Economics, Economic and environmental values, Concept of Supply and Demand; Producer and Consumer Surplus
9-16	**UNIT II –Economic Analysis Tools** Tragedy of the Commons, public goods and property rights, externalities, types of externalities, solutions to externalities, market failures
17-24	**Unit III – Valuing environment** Economic valuation methods - Techniques for valuation, case studies, Cost-Benefit Analysis, discounting, environmental accounting.
25-32	**UNIT IV- Trade and environment** Concept of sustainable development, climate change, carbon trading and clean development mechanism, Global environmental issues.
34-40	**UNIT V- Controlling environmental problems through economic tools** Command and control policies, polluter pay principle, fees and subsidies, compliances.
40	**Total**
10	**Tutorial**
20	**Field and project**

Suggested Readings:

1. Bhattacharya, R.N. (Ed.) (2001) Environmental Economics: An Indian Perspective. Oxford University Press.
2. Chopra, K. & Dayal, V. (Eds.) (2009) Handbook on Environmental Economics, Oxford University Press.
3. Daly, H. E. & Farley, J.(2004) Ecological Economics: Principles and Applications, Washington, D.C. Island Press
4. Field, B.C. & Field, M. K. (2009) Environmental Economics, McGraw-Hill Publ.
5. Gowdy, J. & Hara, S.O. (1995) Economic Theory for Environmentalists, Delray Beach, FL: St. Lucie Press
6. Kadekodi, G.K. (Ed.) (2004). Environmental Economics & Practice, Oxford University Press.
7. Tietenberg, T. (2000) Environmental and Natural Resource Economics, Addison Wesley-Longman, Reading, MA.

Biogeochemical Cycles

Course Details			
Course Title: Biogeochemical Cycles			
Course Code	MSESC3008E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group tasks, group and individual field based assignments followed by seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course deals in detail with the geological, biological chemical processes involved in the cycling of important elements such as carbon, nitrogen and phosphorus,

Learning Outcomes

- The student will able to understand the basics principles of the major biological and chemical process of nutrients and metal cycling. In addition, student will able to understand how human activities disrupted these cycles which leads to environmental problems like global warming and acidification.

Course Contents

Unit 1- Origin of elements, life and evolution of metabolic pathways **(9% Weightage)**

Unit 2 - Geology- minerals, weathering and soil development, lithosphere **(10% Weightage)**

Unit 3 - Biological and chemical processes in elemental recycling **(7 % Weightage)**

Unit 4 - Role of microbes in biogeochemical cycling **(9 % Weightage)**

Unit 5 - Global Carbon cycle (Budget, Pool, fluxes) - terrestrial and aquatic ecosystems **(12 % Weightage)**

Unit 6 - Oceans, wetlands and forests as carbon sinks **(8 % Weightage)**

Unit 7 - Global cycles of nitrogen and phosphorus (Budget, Pool, fluxes) **(8 % Weightage)**

Unit 8. Nutrient (Nitrogen, Sulphur and Phosphorus) cycling in terrestrial and aquatic ecosystems **(13 % Weightage)**

Unit 9. Metals in biogeochemical cycling **(10 % Weightage)**

Unit 10. Nutrient limitation and stoichiometry in aquatic ecosystem **(5% Weightage)**

Unit 11. Anthropogenic disruptions of Carbon, Phosphorus and Nitrogen Cycles **(9 % Weightage)**

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Unit 1. Origin of elements, life and evolution of metabolic pathways
5-9	Unit 2. Geology- minerals, weathering and soil development, lithosphere
10-12	Unit 3. Biological and chemical processes in elemental recycling
13-16	Unit 4. Role of microbes in biogeochemical cycling
17-22	Unit 5. Global Carbon cycle (Budget, Pool, fluxes) - terrestrial and aquatic ecosystems
23-26	Unit 6. Oceans, wetlands and forests as carbon sinks
27-30	Unit 7. Global cycles of nitrogen and phosphorus (Budget, Pool, fluxes)
31-36	Unit 8. Nutrient (Nitrogen, Sulphur and Phosphorus) cycling in terrestrial and aquatic ecosystems
37-40	Unit 9. Metals in biogeochemical cycling
41-42	Unit 10. Nutrient limitation and stoichiometry in aquatic ecosystem
42-45	Unit 11. Anthropogenic disruptions of Carbon, Phosphorus and Nitrogen Cycles
15 Hours	*Practical*

Suggested Readings:

- Jacobson, M.C. et al. (Eds) (2000) Earth system Science: From biogeochemical cycles to global climate change, Elsevier-Academic Press, San Diego, Ca.
- Schlesinger, W.H. (1997) Biogeochemistry: An analysis of global change, Academic Press, San Diego, Ca.
- Berner, E. &Berner, R (2006) Global Environment: Water, Air and Geochemical Cycles, Princeton University Press.
- Butcher, S.S., Charlson, R.J., Orians , G.H. & Wolfe, G.V. (Eds)(1992|) Global biogeochemical cycles (International Geophysics), Academic Press
- Fenchel, T., Blackburn, H. & King, G.M. (2012). Bacterial Biogeochemistry: The Ecophysiology of Mineral Cycling. Academic Press

Eco-toxicology and Environmental Health

Course Details			
Course Title: :	Eco-toxicology and Environmental Health		
Course Code	MSESC3009E04	**Credits**	4
L + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (p) Hours
Methods of Content Interaction	Lecture, practical, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand the basic concepts of toxicology
- To evaluate the response of doses in different organisms
- To assess the exposure and chemical toxicity
- Environment and public health assessment.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand the xenobiotic chemicals
- Their role and effect towards ecosystems
- Analyze/ detection of chemicals of anthropogenic chemicals
- About the occupational health hazards

Course Contents

Unit 1 - Introduction to Ecotoxicology: Sources and forms of toxic materials, radioactivity and the environment, exposure, transformation, elimination, and dispersion processes of toxic materials. (11% weightage)

Unit 2 - Dose-response relationships: LC50 and LD50, acute vs. chronic toxicity, Bio-accumulation, bio-magnification. (11% weightage)

Unit 3 - Chemical toxicology: source, mode of action, toxicity of metals (lead, Cd etc), non metals / gases (CO, SO2, cyanide etc), metalloids (As etc.), Hydrocarbons and halogenated hydrocarbons, Pesticides, persistent organic pollutants, radionuclides. (19% weightage)

Unit 4 - Assessment of toxic effects at organism level: biochemical and molecular biomarkers; physiological, reproductive and behavioral indicators. (11% weightage)

Unit 5 - Assessment of toxic effects at population, community and ecosystem level (8% weightage)

Unit 6 - Methods of detecting and assessing pollution / toxicity: Bioassays for water, soil and sediment toxicity, Biological monitoring and indicator organisms. (12% Weightage)

Unit 7 - Environmental, Public and Occupational health: Role of environmental health in community, environmental and occupational toxicology. Human Exposure to toxics: routes, local effects, gastrointestinal absorption, respiratory absorption, skin absorption. Systemic Toxicity/Target Organs: Neurotoxins, Hemotoxins; Hepatotoxins and nephrotoxins. Immunotoxins; Mutagens, carcinogens, teratogens. (17% weightage)

Unit 8 - Ecological Risk Assessment (11% weightage)

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	Unit/Topic/Sub-Topic
1-5	Unit 1.Introduction to Ecotoxicology
6-13	Unit 2.Dose-response relationships
14-20	Unit 3.Chemical toxicology
21-27	Unit 4.Assessment of toxic effects at organism level
28-31	Unit 5.Assessment of toxic effects
32-37	Unit 6. Methods of detecting and assessing pollution / toxicity
38-41	Unit 7.Environmental, Public and Occupational health
42-45	Unit 8.Ecological Risk Assessment
15 Hours	Practical

Suggested References:

1. Walker, C.H., Hopkin, S.P., Sibly, R.M. & Peakall, D.B. (Eds.) (2006) Principles of Ecotoxicology, Taylor & Francis, New York
2. Wright, D.A. & Welbourn, P. (2002.) Environmental Toxicology, Cambridge University Press, New York,
3. Landis, W.G. & Yu, M.H. (2003) Introduction to Environmental Toxicology, Lewis Publishers, Florida.
4. Newman, M.C. & Unger, M.A. (2003) Fundamentals of Ecotoxicology, Lewis Publishers, Florida.
5. Connell, D., Lam, P., Richardson, B. & Wu, R. (1999) An Introduction to Ecotoxicology, Blackwells
6. Rapport, D., Costanza, R., Epstein, P.R., Gaudet, C. & Levins, R. (1998) Ecosystem health, Blackwells.
7. Yu, M.H. (2004) Environmental toxicology: biological and health effects of pollutants, CRC Press.
8. Yassi, A., Kjellström, T., de Kok, T., Guidotti, T. (2001) Basic Environmental Health. Oxford University, Press
9. Butler, G.C. (1978) Principles of Ecotoxicology (SCOPE) John Wiley & Sons Ltd

Environmental Modeling

Course Details			
Course Title: Environmental Modeling			
Course Code	MSESC3010E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

This course deals with basic mathematics used formulation of mathematical models, model calibration and validation according to physical conditions in air, water and climate models and development of skills of programming for running mathematical models.

Learning Outcomes

After completion of the course the learners will be able to:

- How modeling is done
- Important models of Atmosphere, Air, and Water
- Computer programing and commands for running mathematical models

Course Contents

UNIT I: (35.7.6% Weightage)

Function (Implicit and explicit), Series (Infinite series, Taylor series, convergence/divergence), Interpolation techniques, Difference scheme, Differential equation, Numerical solution of partial differential equation, Newton's Raption Method, Time discretization

UNIT II: (26.6% Weightage)

Model and modeling, Physical models, Conceptual models, Simulation models, Empirical Models, Deterministic & Stochastic Models, Mathematical Models, Model's Calibration, validation, Equations, Input and output data, sensitivity experiments, Uncertainty in the model

UNIT III: (22.2% Weightage)

Air dispersion models (Gaussian plume dispersion model), Hydrological model (SWAT), Climate models (GCM/RCM)

UNIT IV: (15.5% Weightage)

Essential computer programming (F77), UNIX/LINUX, R software, MatLab

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-16	Function (Implicit and explicit), Series (Infinite series, Taylor series, convergence/divergence), Interpolation techniques, Difference scheme, Differential equation, Numerical solution of partial differential equation, Newton's Raption Method, Time discretization
17-28	Model and modeling, Physical models, Conceptual models, Simulation models, Empirical Models, Deterministic & Stochastic Models, Mathematical Models, Model's Calibration, validation, Equations, Input and output data, sensitivity experiments, Uncertainty in the model
29-38	Air dispersion models (Gaussian plume dispersion model), Hydrological model (SWAT), Climate models (GCM/RCM)
39-45	Essential computer programming (F77), UNIX/LINUX, R software, MatLab
15 Hours	Tutorials

- Suggested References:

- Agarwal, N.K. (2004) Essentials of GPS, Spatial Network Pvt.
- Boubel et al. (1994) Fundamentals of Air Pollution, Academic Press
- Milton, B.R. (2005) Fundamentals of Stack Gas Dispersion, 4th Edition, author-published, ISBN 0-9644588-0-2. This book is available as downloadable, ebook in pdf format.
- Rushton, K.R. (2003) Groundwater Hydrology: Conceptual and Computational Models, John Wiley and Sons Ltd.
- Sorooshian, S. (2008) Hydrological Modelling and the Water Cycle: Coupling the Atmospheric and Hydrological Modelling, John Wiley & Sons
- McGuffie, K. & Sellers, A. H. (2003) A Climate Modelling Primer, John Wiley & Sons
- Rajaraman, V. (2003) Computer Programming in Fortran 77, PHI Learning Pvt. Ltd

SEMESTER – IV

Environmental Biotechnology

Course Details			
Course Title: **Environmental Biotechnology**			
Course Code	MSESC4002E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 0 (T) +15 (P) Hours
Methods of Content Interaction	Lecture, Field visit, Practical, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course outlines:

This course will provide the modern concepts and practical aspects of genetic engineering with microorganisms and its application for remediation of the environmental pollutants as well application for human welfare, microbial ecology of soil and aquatic environments, microbial interactions and biogeochemical cycling etc. This course will also impart knowledge about the application of biotechnology for environmental resource management.

Objectives:

- To inculcate among learners deep appreciation for ecofriendly methods of managing the ecosystem
- To highlights the practical aspects of genetic engineering with microorganisms and its application for remediation of the environmental pollutants.

Learning Outcomes

After completion of the course the learners will be able to:

- Use biotechnological methods in managing the ecosystem
- Understand various approaches of bioremediation
- Learn various threats to traditional know how of maintaining indigenous biological resources.

Course Contents

Unit 1. Basic concepts of Environmental Biotechnology:

Concepts of environmental biotechnology, Principle and Application of Biotechnology in Environmental Sciences, Biofilm, Quorum sensing and Quorum Quenching. **GMO technology and environment:** Recombinant DNA technology, GMO (transgenic plants and animals) for human welfare. Consequences of GMO on Environment. Issues related to Bt brinjal and Bt cotton.

Unit 2. Xenobiotics and Biodegradation:

Xenobiotics, biodegradation of Polychlorinated biphenyls (PCBs), biodegradation of halogenated hydrocarbons and PAH compounds, pesticides and detergents. Aerobic system and Anaerobic system biodegradation, Biodegradation of Oil *spills* in ocean, Biodegradable plastics production from microorganisms.

Technology for bioremediation: Use of Genetically engineered microorganisms (GEMs) for environmental remediation, Role of plants and microbes in In-situ and Ex-situ bioremediation of contaminated ecosystems, Release of GEMs in environment, Heavy metal bioremediation.

Unit 3. Environmental Biotechnology for alternative energy generation: Fermentation, Biogas, Biofuel, Bioethanol, petrocrops, zatropha.

Environmental Biotechnology for management of resources: Role of environmental biotechnology in management of resources, Bioprospecting, biopiracy, Microbially enhanced metal recovery, Microbially enhaced oil recovery (MEOR), Inventory of Biodiversity with DNA barcoding, Biotechnology in conservation of biota.

Content Interaction Plan:

Lecture cum Discussion in hours	Unit
1-15 hours	Unit 1. Basic concepts of Environmental Biotechnology:
16-30 hours	Unit 2. Xenobiotics, Biodegradation & Technology for bioremediation
31-45 hours	Unit 3. Environmental Biotechnology, alternative energy generation and management of biological resources
15 Hours	*Practical and Report*

Suggested References:

- Scragg, A.H. (2005) Environmental Biotechnology, Oxford University Press.
- Rittmann, B.E. & McCarty, P.L.(2011) Environmental Biotechnology: Principles and Applications, McGraw Hill.
- Evans, G.M. & Furlong, J.C. (2003) Environmental Biotechnology: Theory and Application, John Wily and Sons publication.

Biodiversity and Conservation Biology

Course Details			
Course Title:	Biodiversity and Conservation Biology		
Course Code	MSESC4003E04	**Credits**	4
L + T + P	2 + 1 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	30 (L) + 15 (T) +15 (P) Hours
Methods of Content Interaction	Lecture, Field visit, Practical, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Outlines:

Although India is blessed with a very rich biodiversity, many of its plants, animals and microbes are yet to be discovered and described. Presently many species are facing the threat of extinction due to anthropogenic activities. Conservation of biodiversity is crucial for the sustainable utilization of biological resources. The course lays the foundation for understanding our rich biodiversity and its multifarious services and presents the scientific principles of conserving wildlife.

Objectives:

- To inculcate among learners deep appreciation for bio-diversity and linkage of humans with other life forms.
- To highlights the role of biodiversity in maintaining the integrity of the ecosystem.
- To provide basic understanding of distribution, utilization, conservation and management of wild life and forest resources.
- To delve upon various methods of biodiversity conservation and its success story.

Learning Outcomes

After completion of the course the learners will be able to:

- Have appreciation for all life forms
- Understand various ecosystem services provided by the biodiversity
- Learn various threats to Biodiversity.
- Develop innovative way to conserve biodiversity.
-

Course Contents

Unit 1. General concepts in biodiversity;

1. Definition and Levels of diversity - Functional diversity, Phylogenetic diversity. Regional and global patterns of diversity (latitudinal, altitudinal, insular, etc., Species-Area relationships). Ecological and evolutionary factors affecting biodiversity. Genetic diversity- varieties, populations, etc. Species diversity- Measurement; (Indices of diversity and equitability). Global and Indian biodiversity data. Ecosystem diversity- biomes, mangroves, coral reefs, wetlands, etc

Unit 2. Trends of biodiversity decline;

Historical trends of biodiversity decline and valuing biodiversity: Threats to biodiversity: Extinctions- natural and anthropogenic; Habitat destruction, fragmentation, degradation, climate change; Overexploitation; Invasive species and diseases. Valuing biodiversity- Ecological economics, Ecosystem services, Direct and indirect benefits; Bio-prospecting

Unit 3. Biodiversity conservation

History of conservation movement- International and Indian; Island biogeography and Theory of Conservation; Ecologically relevant parameters (minimum viable population, minimum dynamic area, effective population size, metapopulations); IUCN categories-endangered, threatened, vulnerable etc. Methods of conservation*: in situ* and *ex situ;* Biosphere reserves, National Parks, Sanctuaries, Biodiversity hotspots. Designing and managing protected area. Stake holders in conservation. Conservation ethics

Content Interaction Plan:

Lecture cum Discussion in hours	**Unit**
1-10 hours	Unit 1. General concepts in biodiversity
10-15 hours	Unit 2. Trends of biodiversity decline;
15-30 hours	Unit 3. Biodiversity conservation
15 Hours	*Tutorials field work*
15 Hours	*Practical and Report*

- Suggested References:

7. Biodiversity Profile of India. ces.iisc.ernet.in/hpg/cesmg/indiabio.html
8. Daily, G. C. (ed.) (1997) Nature's Services: Societal Dependence on Natural Ecosystems, Island Press, Washington, D.C.
9. Gaston, K J. & Spicer, J.I. (1998) Biodiversity: An Introduction, Blackwell Science, London, UK.
10. Groombridge, B, & Jenkins, M. (2000) Global Biodiversity: Earth's Living Resources in the 21st Century, World Conservation Press, Cambridge, UK.
11. IUCN 2004. Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland
12. Lovejoy, T. E. & Hannah, L. (eds), (2006) Climate change and Biodiversity, Yale Univ. Press, Yale, CT.
13. Magurran, A. E. (2003) Measuring biological diversity, Wiley-Blackwell,
14. Wilson, E. O. (1993) *Diversity of Life*, Harvard University Press, Cambridge, MA.
15. Sutherland, W. (2000) The Conservation Handbook, John Wiley.
16. Meffe, G.K. & Carroll, C.R. (2005) Principles of Conservation Biology, Sinauer Associates.
17. Primack, R. B. (2002) *Essentials of Conservation Biology***,** Sinauer Associates, Sunderland, Ma. USA
18. Loreau, M. & Inchausti, P. (2002). Biodiversity and ecosystem functioning: Synthesis and Perspectives, Oxford University Press, Oxford, UK.

Microbial Ecology

Course Details			
Course Title: **Microbial Ecology**			
Course Code	MSESC4004E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45(L) + 0 (T) + 15 (P) Hours
Methods of Content Interaction	Lecture, Practical, report writing, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

Microbes are the most abundant and diverse organisms on the Earth. Collectively, they are responsible for regulating the flow of energy and cycling of elements in the soil, water, and atmosphere. Furthermore, microorganisms are important for producing food and for keeping us healthy. In this course, we will explore the evolutionary and ecological processes that generate and maintain microbial biodiversity. Students will be exposed to contemporary microbiological, molecular, and bioinformatic approaches that are used to study microorganisms in a variety of habitats, including soils, oceans, and the human gut.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand about the different microbial world and their role in ecosystem functioning.
- Apply ecofriendly methods of vector control using microbial insecticides
- Differentiate between useful and harmful microbes.
- Have Substantial knowledge about various methodological and analytic approaches that may be useful for ecosystem restoration and conservation.

Course Contents

Unit 1. Microbial classification and basics of microbial diversity-

Five kingdom classification of microbes, definition of microbial diversity and mode of evolution; microbial phylogeny; structural diversity of microbes, Physiological diversity of microorganisms; prokaryotic diversity; eukaryotic microorganism; Microbial taxonomy, Phylogeny of *Archea*; extremophils; commercial uses of extremophils; microbial diversity and its application in modern science. Marine ecosystem: Environment of marine bacteria, bacterial growth in sea and its regulation by environmental conditions, modeling of growth and distribution of marine micro plankton, mechanism of dissolved, organic matter production (DOM), strategies of organic matter utilization and microbial utilization of organic matter in sea.

Unit 2. Microbial community ecology- Concept, development of microbial community in biosphere, biofilm and its ecological implication. Microbial diversity, extremophiles-ecological adjustment and molecular adaptations in extreme conditions. Nutrient acquisition, microbial competition and antagonism, environments and micro environments, Association of microbes with eukaryotes, Rumen micro flora, Aquatic habitats: Marine and fresh water; terrestrial habitats; Benevolent interactions (control within the microbial communities of rhizosphere), antagonistic interactions, (competition, antibiosis, predation etc.). Rhizosphere, rhizoplane, siderophore, flavonide from plants, lectines, octapine, nipotine, indole acetic acid. Extreamophiles: halophiles, thermophiles, psychrophiles, mechanisms of resistance, alkalophiles and acidophiles.

Unit 3. <u>Application of microbes Microbial insecticides-</u> types, microbes used production of inoculants and application. Host-parasite interaction. Important diseases in agricultural crops by bacteria (crown gall), viruses (CaMV) and fungi (rust of wheat) and their control (chemical & biological). Microbial diseases of aquacultural animals- finfish and shell fish.
Microbial assessment of water quality, microbes as bio-indicators, potability of water, treatment of municipal water.Solid and liquid based treatment, biological (aerobic, anaerobic, primary, Secondary & tertiary) treatment. Microbial bioremediation, bioleaching, biodegradation, biomining.

Microbial remediation of xenobiotics. Microbial assessment of water quality, microbes as bio-indicators, potability of water, treatment of municipal water.Solid and liquid based treatment, biological (aerobic, anaerobic, primary, secondary & tertiary) treatment.

<u>Content Interaction Plan:</u>

Lecture cum Discussion in hours	**Unit**
1-15 hours	Unit 1. Microbial classification and basics of microbial diversity
16-30 hours	Unit 2. Microbial community ecology
31-45 hours	Unit 3. Applied microbial Ecology
1-15 Hours	*Practical, field work, report*

Suggested References:

1. Processes in Microbial Ecology (1st Edition) by David L. Kirchman (2012).
2. Brock Biology of Microorganisms, 13th Edition Michael T. Madigan, John M. Martinko, David A. Stahl, and David P. Clark. ISBN-10: 032164963X ; ISBN-13: 9780321649638 Publisher: Pearson- Benjamin Cummings.
3. Microbial Diversity, D.Colwd
4. Microbial Ecology, J.M.Lynch and N.J.Poole
5. Microbial Ecology, Atlas and Bartha.

Practicals: Wet mount, smear and hanging drop preparations Micrometry-Determination of size of microorganisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, dry heat, moist heat, chemical agents Cultivation technique: Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Collection, isolation and culture of zooplankton and microalgae.

Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems.

Industrial Environment Management

Course Details			
Course Title: Industrial Environment Management			
Course Code	MSESC4005E04	**Credits**	4
L + T +P (project)	2+1+1	**Course Duration**	One Semester
Semester		**Contact Hours**	30 (L) + 10 (T) +20(P)
Methods of Content Interaction	Project based learning process; Lecture, Tutorials, Group discussion; Case study, seminar, presentations by students, group and individual field based assignments,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- Understand environmental management system (EMS), LCA, TEQM concepts, and guidelines
- To provide understanding on various environmental tools and methods which are integrated in overall management process of the industry strengthening the proactive environmental decision making.
- o understand the solid waste management aspects and disposal techniques.
- To understand the role of institutions and regulatory requirements.
- To enable students to understand of the concept of Waste Management, Minimization and Utilization.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand the purpose of environmental management system and its benefits
- Understand the audit related process and documents
- Apply the tools in industries for better environmental management and corporate image.

Course Contents

UNIT I – Introduction to Environmental Management System (25 % Weightage)

Introduction to Environmental Management System (EMS), key elements of an EMS, steps involved in implementing EMS, ISO certification and benefits. 1. International Organization for standardization (ISO): Duties and function, basic total quality management concept, techniques and implementation requirements.

UNIT II – Life Cycle Assessment (15% Weightage)

Introduction, definitions, application areas of LCA, LCA methodological framework.

Unit III – Corporate Environmental Management (20 % Weightage)

Definitions of CEM, concepts for implementation of CEM, Environmental performance indicator and types, Pollution Prevention and Total Quality Environmental Management (TEQM), Environmental communication and reporting, eco labeling, Extended Producer Responsibility, Corporate social responsibility

UNIT IV- Auditing and networking (20 % Weightage)

Scope and objectives, standards for auditing, environmental auditing process, case studies, Eco Industrial networking- Concept, definition and case studies, Preparation of environmental management plan

UNIT V- Environmental problems in Industries (20 % Weightage)

Process description, waste/emission generation sources, pollution prevention, and treatment, case studies (Cement, pulp and paper, dairy). Project work

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-10	**UNIT I – Introduction to Environmental Management System** Introduction to Environmental Management System (EMS), key elements of an EMS, steps involved in implementing EMS, ISO certification and benefits. 1. International Organization for standardization (ISO): Duties and function, basic total quality management concept, techniques and implementation requirements.
11-17	**UNIT II – Life Cycle Assessment** Introduction, definitions, application areas of LCA, LCA methodological framework.
18-25	**Unit III – Corporate Environmental Management** Definitions of CEM, concepts for implementation of CEM, Environmental performance indicator and types, Pollution Prevention and Total Quality Environmental Management (TEQM), Environmental communication and reporting, eco labeling, Extended Producer Responsibility, Corporate social responsibility
26-34	**UNIT IV- Auditing and networking** Scope and objectives, standards for auditing, environmental auditing process, case studies, Eco Industrial networking- Concept, definition and case studies, Preparation of environmental management plan
35-40	**UNIT V- Environmental problems in Industries** Process description, waste/emission generation sources, pollution prevention, and treatment, case studies (Cement, pulp and paper, dairy). Project work
40	**Total**
10	**Tutorial**
20	**Field and project**

Suggested Readings:

1. Darabaris, J. (2008) Corporate Environmental Management, CRC press, Boca Raton
2. Sheldon, C. & Yoxon, M. (2006) Environmental Management Systems, Earthscan, London.
3. Zoran Morvay, K. (2008) Applied Industrial Energy and Environmental Management, IEEE-Wiley.

ENVIRONMENTAL ENTREPRENEURSHIP

Course Details			
Course Title: Environmental Entrepreneurship			
Course Code	MSESC4006E04	**Credits**	4
L + T +P (project)	3 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	30 (L) + 10 (T) +20(P)
Methods of Content Interaction	Project based learning process; Lecture, Tutorials, Group discussion; Case study, seminar, presentations by students, group and individual field based assignments,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To allow students to experience and become imbued with the principles of nature as a source of life and inspiration in order to develop their green mindset as future entrepreneurs.
- To gain knowledge on how market forces can be harnessed to encourage private solutions to environmental concerns.
- To understand creativity, innovation and entrepreneurship in the field of sustainable development and environmental studies.
- To strengthen entrepreneurial quality and motivation in students.
- To understand sustainable exploitation of opportunities to create social change that positively transforms the environment

Learning Outcomes

After completion of the course the learners will be able to:

- To develop new skills and competencies required for green jobs and green entrepreneurship.
- Understand the domain of environmental services where a venture can be started
- Know the role of startups in environmental service sector.

Course Contents

UNIT I – Introduction to Environmental Entrepreneurship (20 % Weightage)

Introduction to Sustainability, innovation and entrepreneurship: understanding green entrepreneur, types of sustainable entrepreneurship and conditions for sustainability innovation, Innovation driven by environmental ambition. enhancing environmental entrepreneurship through an environmental management system, potential areas for Environmental Entrepreneurship. How to start up and manage a green business, cases of sustainable start-ups.

UNIT II – Entrepreneurship and motivation (15% Weightage)

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives. Creativity and entrepreneurship

Unit III – Business Plan for New Environmental Ventures (15 % Weightage)

Making money by saving the world, Meaning and Objectives of a Business Plan, Small Enterprises – Definition, Classification, Concept of Non Profit Organizations, NGOs, Companies, Factories, Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment, Advantages and cost of preparing a Business Plan, Critical Assessment.

UNIT IV- Financing the solution (15 % Weightage)

Startup policy of state and central Government, Bank linkages, Sources of finances, loans, Break Even Analysis, Fundraising and venture capital; The Green Startup

UNIT V- Advertising and marketing for sustainability innovation (10 % Weightage)

Foundations of public relations and strategies and tools for gaining media attention for your new venture, introduction to advertising including effective campaign, environmental practices and customer, satisfaction in services, Marketing and adoption of environmentally friendly products, Obstacles to commercialization of clean technology.

UNIT VI- My green solution for future (25 % Weightage)

Project work and case study

Content Interaction Plan:

Lecture / Discussion /Evaluation (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
8	UNIT I – Introduction to Environmental Entrepreneurship
6	UNIT II – Entrepreneurship and motivation
8	Unit III – Business Plan for New Environmental Ventures
5	UNIT IV- Financing the solution
3	UNIT V- Advertising and marketing for sustainability innovation
	UNIT VI- My green solution for future
30	Total
10	Tutorial
20	Project

Suggested Readings:

7. Koester, E. (2011) Green entrepreneur handbook, CRC Press, Taylor & Francis Group, Boca Raton, FL 33487-2742.
8. Schaper, M. (2010), Making Ecopreneurs Developing Sustainable Entrepreneurship, Gower Publishing Limited, Wey Court East, Surrey, England.
9. Jones, G. (2017), Profits and sustainability : A History of Green Entrepreneurship Oxford University Press, United Kingdom
10. Gardetti, M.A. and Muthu, S.S. (2018) Sustainable Luxury, Entrepreneurship, and Innovation, Springer Nature Singapore Pte Ltd.
11. Fayolle, A. and Kyrö, P. (2008), The Dynamics between Entrepreneurship, Environment and Education, Edward Elgar, Cheltenham, UK • Northampton, MA, USA

Soil Science

Course Details			
Course Title: Soil Science			
Course Code	MSESC4007E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group tasks, group and individual field based assignments followed by seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course is designed to provide an overview of the fundamental concepts in soil science: Genesis, Classification, Physics, Chemistry, and Biology. The objective of the course is to provide the student to build their fundamental knowledge and skills within the different areas of soil science.

Learning Outcomes

The students will also able to understand the linkages between soil and environment. In addition, student will able to manage soil contamination and degradation also.

Course Contents

Unit 1: Soil Genesis: Weathering processes and soil formation. Soil profile development, chemical mineralogical composition of soil. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil Taxonomy and Soil classification. **(26 % weightage)**

Unit 2: Soil Physics: Soil texture – textural classes. Soil structure – classification, soil aggregate ion and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance. Soil moisture, Movement of soil water, Infiltration, Percolation, Permeability, Soil air- composition, gaseous exchange. Soil erosion and types, Soil erosion by water, wind and other agents, Characterization and evaluation of soil and land quality indicators **(22 % weightage)**

Unit 3: Soil Chemistry: Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, Charge development on clays and organic matter; Buffer capacity of soils. Soil Organic Matter: Sources, composition, Humus formation, Nature and properties of humus, Clay-Humus complex, significance of C:N ratio, Cation exchange theories, Soil reaction: soil alkalinity and acidity **(27 % weightage)**

Unit 4: Soil Biology: Soil as biological habitat, Soil organisms and soil microbial ecology, types of organisms. Soil microbial biomass carbon, microbial interactions, Microbiology and biochemistry of root-soil interface, Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Biochemical composition and biodegradation of soil organic matter and crop residues, Soil Sickness due to biological agents; toxins and antibiotic production in soil. **(25 % weightage)**

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-12	**Unit 1: Soil Genesis:** Weathering processes and soil formation. Soil profile development, chemical mineralogical composition of soil. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil Taxonomy and Soil classification.
13-22	**Unit 2: Soil Physics:** Soil texture – textural classes. Soil structure – classification, soil aggregate ion and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance. Soil moisture, Movement of soil water, Infiltration, Percolation, Permeability, Soil air- composition, gaseous exchange. Soil erosion and types, Soil erosion by water, wind and other agents, Characterization and evaluation of soil and land quality indicators;
23-34	**Unit 3: Soil Chemistry:** Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, Charge development on clays and organic matter; Buffer capacity of soils. Soil Organic Matter: Sources, composition, Humus formation, Nature and properties of humus, Clay-Humus complex, significance of C:N ratio, Cation exchange theories, Soil reaction: soil alkalinity and acidity

35-45	**Unit 4: Soil Biology:** Soil as biological habitat, Soil organisms and soil microbial ecology, types of organisms. Soil microbial biomass carbon, microbial interactions, Microbiology and biochemistry of root-soil interface, Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Biochemical composition and biodegradation of soil organic matter and crop residues, Soil Sickness due to biological agents; toxins and antibiotic production in soil.
15 Hours	*Practical*

Suggested Readings:

- Brady, N.C. & Ray, R.W. (2007) The Nature and properties of soils, Pearson Publications, New Delhi.
- Fundamentals of soil science (2009). Published by Indian Society of soil science, New Delhi.
- Tan, K.H. (2010) Principles of Soil Chemistry, CRC Press.
- Jenny, H. (1941) Factors of soil Formation-A system of quantitative Pedology, McGraw- Hill book Company INC, New York.
- Boul, S.W., Hole, F.B. & McCracken, R.J. (1980) Soil Genesis and Classification, Oxford and IBH Publishing Co, New Delhi.
- Sparks, D.L. (2003). Environmental soil Chemistry, Academic Press London
- Paul, E. (2007) Soil Microbiology, Ecology and Biochemistry, Academic Press.

Statistical Methods and Computer Applications

Course Details			
Course Title: Statistical Methods and Computer Applications			
Course Code	MSESC4008E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

Environmental Science demands adequate knowledge of statistics to analyze trends and test hypotheses based on observed and modeling data. This course provides basic understanding of statistical methods to students.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will be familiar to statistical methods
- Necessary statistical software (R software/SPSS) and MatLab for data analysis in environmental science

Course Contents

UNIT I: (40% Weightage)

Central tendency (Mean, Median, Mode, Standard Deviation, Correlation), Standard error, Cumulative frequency distribution, Percentile, Box and whisker plot, Correlation, Linear regression (bivariate and multivariate), Time series analysis, semi averages, moving averages

UNIT II: (33.3% Weightage)

Parametric and Nonparametric tests (student t test, chi square test, mann-kendal test, F test, Spearman's Test, 1-sample sign test), Hypothesis testing, one tailed and two tailed, Confidence levels, p value

UNIT III: **(15.5% Weightage)**

Discrete and continuous probability distribution, Probability distribution function Binomial, Normal and possion distribution

UNIT IV : **(11.2% Weightage)**

Basic concept of R software/SPSS, Working knowledge of MatLab

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-18	Central tendency (Mean, Median, Mode, Standard Deviation, Correlation), Standard error, Cumulative frequency distribution, Percentile, Box and whisker plot, Correlation, Linear regression (bivariate and multivariate), Time series analysis, semi averages, moving averages
19-33	Parametric and Nonparametric tests (student t test, chi square test, mann-kendal test, F test, Spearman's Test, 1-sample sign test), Hypothesis testing, one tailed and two tailed, Confidence levels, p value
34-40	Discrete and continuous probability distribution, Probability distribution function Binomial, Normal and possion distribution
41-45	Basic concept of R software/SPSS, Working knowledge of MatLab
15 Hours	Tutorials

- Suggested References:

- Sokal, R.R. & Rohlf, F.J. (1995) Biometry, W. H. Freeman, San Francisco, CA, USA
- Zar, J. H. (1999) Biostatistical Analysis Pearson Education Publ. (Indian Edition)
- Ludwig, J. A. & Reynolds, J.F. (1988) Statistical Ecology: A Primer on methods and computing, John Wiley & Sons.
- Fundamentals of Mathematical Statistics, Gupta and kapoor, S Chand and Sons
- Fundamentals of Statistics, S C Gupta, Himalayan publication ISBN Number : 978-93-5051-769-7

Remote Sensing and GIS

Course Details			
Course Title: Remote Sensing and GIS			
Course Code	MSESC4009E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

This course focuses on basics of Remote Sensing and Geographical Information System (GIS), their various components and how these tools can be used to address various environmental issues and management of natural resources.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will be familiar to basics of remote sensing
- Use of ArcGIS 10. for analyzing satellite pctures

Course Contents

UNIT I: (26.6% Weightage)

Electromagnetic Radiations, Atmospheric Windows, Active & passive sensors, Optical, Thermal and Microwaves remote sensing, Spectral Signatures, Spectral Response pattern of soil, Vegetation & water

UNIT II: (13.4% Weightage)

Electromagnetic Radiations, Atmospheric Windows, Active & passive sensors, Optical, Thermal and Microwaves remote sensing, Spectral Signatures, Spectral Response pattern of soil, Vegetation & water

UNIT III: (4.4% Weightage)

Digital Image Processing, Spatial, Radiometric and Temporal Resolution, True and False Color Composites (FCCs)

UNIT IV: **(13.4% Weightage)**

Atmospheric Radiometric and Geometric Corrections, Contrast Enhancement, Filtering Band Ratio and Vegetation Indices, Supervised and Unsupervised classification

UNIT V: **(13.4% Weightage)**

Elements of GIS: Raster and Vector Formats, TIN, DEM, Spatial Data Analysis: Data Manipulation techniques, Overlay Operations

UNIT VI: **(28.8% Weightage)**

Working knowledge of ArcGIS, Application of Remote Sensing and GIS techniques in Natural resource management

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-12	Electromagnetic Radiations, Atmospheric Windows, Active & passive sensors, Optical, Thermal and Microwaves remote sensing, Spectral Signatures, Spectral Response pattern of soil, Vegetation & water
13-18	Characteristic of Aerial photography and acquisition of aerial photographic data, Image Interpretation techniques
19-20	Digital Image Processing, Spatial, Radiometric and Temporal Resolution, True and False Color Composites (FCCs)
21-26	Atmospheric Radiometric and Geometric Corrections. Contrast Enhancement, Filtering Band Ratio and Vegetation Indices, Supervised and Unsupervised classification
27-32	Elements of GIS: Raster and Vector Formats, TIN, DEM, Spatial Data Analysis: Data Manipulation techniques, Overlay Operations
33-45	Working knowledge of ArcGIS, Application of Remote Sensing and GIS techniques in Natural resource management
15 Hours	Tutorials

- Suggested References:
- Agarwal, N.K. (2004) Essentials of GPS, Spatial Network Pvt.
- Aronoff, S. (1993) Geographical Information Systems, WDL Publ.

- Lillesand, T., & Keifer, R.W. (2007) Remote Sensing & Image Interpretation. John Wiley & Sons.
- Campbell, J.B. (1996) Introduction to Remote Sensing, Taylor & Francis,
- Jensen, J. R. (2000) Remote Sensing of the Environment: Pearsons Education Pub.
- Joseph, G. (2005) Fundamental of Remote Sensing, University Press, India
- Cracknell, A.P., & Hayes, L.(2007) Introduction to Remote Sensing, CRC Press
- Guha, P.K.(2008) Remote Sensing for the Beginner, Affiliated East-West Press Pvt. Ltd.
- Reddy, M.A. (2001) Remote Sensing and Geographical Information Systems, BS Publication
- Purkis, S.J., & Klemas,V.V. (2011) Remote sensing and Global Environmental Change, Wiley Blackwell