SCHEME OF EXAMINATION

AND SYLLABUS

OF

MASTER OF SCIENCE
(ENVIRONMENT MANAGEMENT)

(ACADEMIC SESSION 2015-2016)

Programme Code - 047

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
New Delhi 110078

PREFACE

University

Guru Gobind Singh Indraprastha University, established by Government of NCT of Delhi under the provisions of Guru Govind Singh Indraprastha University Act, 1998 is an affiliating and teaching university that aim to facilitate and promote studies, research and extension work in newly emerging areas of higher education with focus on professional education in the disciplines of engineering, technology, architecture, management studies, environment, medicine, pharmacy, nursing, education, law, journalism and mass communication, etc. and also to achieve excellence in these and connected fields and other matters related therewith or incidental thereto.

Within a short span of sixteen years, the University has been able to make its presence felt the world over. It is running over 106 programmes in 10 University Schools of Studies and 108 Institutes (Government as well as self financing) imparting professional educational to more than 70,000 students with an annual intake of about 10,000. Prominent amongst the courses being offered are B. Arch., BBA, BCA, BHMS, BHMCT, B(MC), BPT, B.Sc. (Nursing), B.Tech, L.L.B, LL.M, MBA, MBBS, MCA, MPT, M.Sc. (Criminology and Forensic Science), M.Tech. M.Sc. etc.

Choice based Credit System

University follows Credit System of syllabi and examination. UGC has recently given guidelines for choice based credit system with a defined nomenclature for designing scheme of examinations and syllabus of different courses. In view of this, Scheme of Examinations and Syllabus have been revised and framed in accordance with the new UGC Guidelines and the courses have been divided into the following categories:

a. Foundation Course
b. Value based Foundation course
c. Generic Elective, (GE) and
d. Open Electives (OE)

Students have been given wide choice in selection of Generic Elective and Open Elective. A student may choose open elective either from the open electives floated by the School or may opt from the open electives offered by other University School of Studies. However, Generic Elective is to be chosen from the Generic Elective Courses offered by the University School of Environment Management.

Examination

The University has adopted the semester, trimester and annual examination system for most of its educational programmes. In addition to the End Term Examination, there is continuous evaluation of student's performance throughout the academic programme. The Odd Semester Examinations are conducted in the month of December-January and Even Semester Examination are Conducted in the Month of May-June every year.

Evaluation and Award of Degree

The overall weightage of a course in the syllabi and Scheme of Examination is determined in terms of credits assigned to the course. Obtaining a minimum of 50% marks in aggregate in each course including the End Term Examination and teacher's continuous evaluation is essential to earn the assigned credits. A student who secures less than 50% of marks in a course is, therefore, deemed to have failed in that course. A Student is eligible for the award of University degree, it he/she has registered himself/herself, has undergone the regular course of studies, completed the project report/dissertation specified in the curriculum of his/her programme within the stipulated time, and has secured the minimum number of credits as prescribed for the award of concerned degree.

Broad Guidelines for Question Paper

The question papers are key tools in assessing student learning process. Question papers are very meticulously planned so as to spread over the entire syllabus and possibly imbibe all components of assessment such as:

1. Knowledge
2. Comprehension
3. Application
4. Analysis & Evaluation
5. Synthesis
6. Creativity & Innovation

Instructions to Paper Setter

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
2. Apart from the question no.1 rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. Student will have to attempt only 1 question from each unit. Each question should be of 12 marks.

Summer Training

1. After 2nd semester students will undergo summer training for six weeks in different industries/institutes.

2. The summer training reports will be evaluated in two parts. The Corporate Executive, under whose guidance the summer training project has been completed, shall award marks out of 50. An internal Board of Examiners will evaluate the work for 50 marks recommended by the Dean.
3. Evaluation will be based on the report and their presentations in the presence of at-least three faculty members of the School.

Dissertation

1. Each student shall carry out a study for dissertation in the 4th Semester either in a research institution and or Govt./Private Organization that specializes in area relevant to the broad area of Environment Management or in-house, at USEM.
2. The Student will submit a synopsis at the beginning of the semester for approval from the department committee in a specified format. The student will have to present the progress of the work through seminars and progress reports. Evaluation of dissertation will be based on thesis and viva/voce by the Board of Examiners comprising the External Expert & Internal Examiner.

Credit Requirement

1. The student will require to earn a minimum of 100 credits for the award of the degree (Ref. GGSIPU/SMS/2000/1850, minutes of the joint Meeting of the Curriculum Development Committee)
2. The student will not have the option to drop any course covered in the scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination.

ENVIRONMENT MANAGEMENT

Code No.	Subject	L	T	P	Credits
First Semester					
EM-601 Foundation Course	Fundamentals of Ecology, Biodiversity and Sustainable Development	**4**			**4**
EM-603	Environmental Chemistry	**3**			**3**
EM-605	Environmental Geosciences & Natural Disasters	**3**			**3**
EM-607	Fundamentals of Geoinformatics	**4**			**4**
EM-609	Energy Resources and Technology	**4**			**4**
EM-611	Environmental Statistics	**4**			**4**
EM-613	**Seminar/Term Paper ***	**1**			**1**
Practicals					
EM-651	Geoinformatics Lab			**4**	**2**
EM-653	Environmental Chemistry, and Energy Lab			**4**	**2**
EM-655	Environmental Statistics and Computer Application Lab			**4**	**2**
					29
Second Semester					
EM-602	Air Pollution, Meteorology and Control	**4**			**4**
EM-604	Water Pollution and Waste water Treatment	**4**			**4**
EM-606	Basic and Applied Environmental Microbiology	**4**			**4**
EM-608	Solid and Hazardous Waste Management	**3**			**3**
EM-610 Value based course	Environmental Policies, Ethics and Legislation	**3**			**3**
	Generic Elective (Any One)				
EMGE-616	Environmental Modelling	**4**			**4**
EMGE-618	Ecotechnology for Environment Management	**4**			**4**
EMGE-620	Environmental Biotechnology	**4**			**4**
EMGE-622	Aquatic Ecosystems and Wetland Management	**4**			**4**
EMGE-624	Geospatial Technology for Environment Management	**4**			**4**
EMGE-626	Watershed Management	**4**			**4**
EMGE-628	Essentials of Urban Forestry and Biodiversity	**4**			**4**
Practicals					
EM-652	Environmental Microbiology Lab			**4**	**2**
EM-654	Air and Water Pollution Lab			**4**	**2**
	Field Visit/Industry Visit				
	Summer Training (6-8 Weeks)				
					26
Third Semester					
EM-701	Environmental Impact Assessment & Risk Analysis	**4**			**4**
EM-703	Ecosystem Management and Restoration	**4**			**4**
EM-705	Industrial Pollution Prevention and Control	**3**			**3**
EM-707	Environmental Health and Safety	**3**			**3**
EM-709	Environmental Instrumentation	**3**			**3**
Practicals					
EM-751	Ecology and ecosystem restoration lab			**4**	**2**
EM-753	Environmental Instrumentation lab			**4**	**2**
*** NUES (Non – University Examination System)**					
EM-755	Visits to Industry/ field visits – Reports and Presentation				**1**

EM-757	***Summer Training Report &Presentation***				**3**
*** NUES (Non – University Examination System)**					

Open-Electives (Any one) **					
EMOE731	Climate change mitigation & adaptation	**4**			**4**
EMOE733	Disaster Risk Reduction and Management	**4**			**4**
EMOE735	Urban Biodiversity Strategies for Conservation	**4**			**4**
EMOE 737	Human aspects of Biodiversity and Environment	**4**			**4**
EMOE739	Corporate Social Responsibility	**4**			**4**
EMOE741	Sustainable Ecotourism	**4**			**4**

Fourth Semester					
EM-752	Seminar and Progress Report				**4**
EM-754	Dissertation				**22**
					26

TOTAL CREDITS: 110

Total No. of credit offered in all four semesters 110

- Summer Training (6-8 Weeks) outside University in any Industry/Organization.
- * *Students will opt for one relevant open elective paper offered by USEM or by any other University School of GGSIPU
- The seminar term paper and industrial field visit report will be evaluated by the board of at least four faculty members constituted and duly approved by the Dean of the school

The student will require to earn 100 credits for the award of the degree. The students will not have the option to drop any course covered in scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination of the programme.

Course Code: EM-601 L:4 T/P:0 Credits: 4

FUNDAMENTALS OF ECOLOGY, BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

UNIT-I

Introduction: Definitions, principles and scope of Environmental Science; evolution of concepts in environmental protection and sustainable development. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.

Biodiversity: origin of new species; species, community and ecosystem diversity, genetic diversity; biological classification – phylogenetic relationships; classifying and naming species; biodiversity and livelihood,threats to biodiversity,and hot spots, IUCN protected area categories.

UNIT-II

Ecology: Definition and scope of ecology, types of ecosystem, abiotic and biotic environments, biotic – abiotic interactions, soil formation,soil types, UNESCO scheme of soil classification.

Population ecology: Population attributes, population changes, survivorship curves, growth models, demographic models, dispersion

Community ecology: Community structure, two-species interactions, food webs, succession, disturbance and succession, negative and positive feedbacks in succession.

Ecosystems ecology: Ecosystem organisation and processes, energy flows, nutrient cycling, hydrological cycling, cycling index.

UNIT-III

Biogeography: Biogeographical zones of India; forest distribution and types (Champion and Seth); terrestrial, aquatic (fresh water and marine) and wetland ecosystems; biomes.

Global issues and human ecology: Greenhouse effect and climate change, ozone depletion, ecosystems responses to long-term climate patterns. Urban ecosystems and hierarchies; Population growth and environment; rainwater harvesting.

UNIT- IV

Sustainability and Sustainable Development: Sustainability theory, sustainability and society (social justice, development, economy), biodiversity and conservation, Desertification and UNCCD, Agenda-21; UNEP programmes towards sustainable development.

Text/References:

1. Michael L. Cain, William D. Bowman, and Saily D. Hacker (2014). Ecology, 3rd Edition. Sinauer Associates Inc. US, 648p.
2. Odum, Eugene P., and Gary W. Barrett. (2007). Fundamentals of Ecology, 5th edition. Thomson Brooks / Cole.
3. Begon, M., Townsend, C. R., and Harper, J. L.(2005). Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA.
4. Gotelli, Nicholas J. (2008). A Primer of Ecology, 4th edition. Sinauer.
5. Stiling, Peter. (2001). Ecology: Theories and Applicatios, 4th edition. Prentice Hall.
6. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. (2007).An Introduction to Sustainable Development. Earthscan.
7. Edwards, Andres R. (2005). The Sustainability Revolution: Portrait of a Paradigm Shift. New Society.
8. Primack, Richard B. (2010).Essentials of Conservation Biology, 5th edition. Sinauer.

Course Code: EM-603 L: 3 T/P: 0 Credits: 3
Course Title: ENVIRONMENTAL CHEMISTRY

UNIT- I

Fundamentals: Concept and Scope of Environmental Chemistry, Environmental Components, Fundamentals of chemical bonds, molecules and compounds, Organic functional groups and classes of organic compounds, Thermodynamics: first, second and third law of thermodynamics, Gibb's Energy, Stochiometry, Solubility of gases in water, Radionuclides.

UNIT-II

Water Chemistry: Acid-base equilibrium, carbonate system, pH and buffers, Oxidation-reduction, Solution processes and solubility, Redox potential, Complexation and chelation reactions, Concept of salinity, Composition of sea water and physico-chemical speciation in ocean.

Water quality parameters, Water pollutants: organic, inorganic, radioactive, thermal, Water disinfection, Tertiary water treatment methods: Adsorption, Defluoridation, Desalinization through distillation, ion exchange, Reverse Osmosis and Electrodylasis, Water softening.

UNIT-III

Soil Chemistry: Composition of soil, micronutrients and macro soil, Nitrogen, phosphorus and potassium in soil, chemical reactions of soil: ion exchange, ligand exchange, complexation, chelation, precipitation, humus formation, wastes and pollutants in soil.

UNIT-IV

Atmospheric Chemistry: Chemical composition of atmosphere: particles, ions and radicals, Chemical processes for formation of inorganic and organic particulate matter, Chemical and photochemical reactions in the atmosphere, Photochemical smog, Acid rain, Oxygen and ozone chemistry.**Green Chemistry:** Concept, Basic principles and tools of Green Chemistry, Zero waste technology.

Text/ References:

1. Manahan, S. E. (2001). Fundamentals of Environmental Chemistry. 2nd ed. CRC Press, Inc., USA.
2. De, A. K. (2000). Environmental Chemistry. 4th ed. New Age International (P) Ltd., New Delhi, India.
3. Banerji, S. K. (1999). Environmental Chemistry. 2nded. Prentice-Hall, New Delhi, India
4. Sodhi, G. S. (2006). Fundamental Concepts of Environmental Chemistry. Narosa Publishing House, New Delhi.
5. Dara, S. S. A Text Book of Environmental Chemistry and Pollution Control. S. Chand Publications, New Delhi.
6. Nelson, D.L. and Cox M.M.Lehninger. (2000). Principle of Biochemistry. Worth Publishers.

Course Code: EM-605 L: 3 T/P: 0 Credits: 3
Course Title: ENVIRONMENTAL GEOSCIENCES AND NATURAL DISASTERS

UNIT-

Terrestrial Environment : Internal structure of earth-crust, mantle and core; surface features of the earth- landforms created by running water, underground water, wind, glacier, sea; types of rocks and rock cycle; erosion and weathering; soil formation, profile, types and conservation.

UNIT- II

Atmospheric Environment: Atmosphere- pressure, temperature, precipitation, humidity and radiation; Cloud classification and formation; La Nina, El Nino phenomenon; Western disturbances. **Aquatic Environment**: Hydrological cycle; sea floor spreading, formation of lakes, coastal environment. **Applied Geology:** Scope of engineering geology; dam, reservoirs and tunnels-geotechnical investigation.

UNIT- III

Disaster Management

Disaster types, Disaster Management Cycle and implementation during disasters, international and national agencies in disaster management; Disaster Management Act 2005, Hyogo Framework (2005-2015), Senedai Framework (2015-2030).

Earthquakes – Seismology, causes, intensity and magnitude of earthquakes, geographic distribution of earthquakes zones, nature of destruction, earthquake mitigation for buildings and dams; seismic zones of India. **Landslides** – Types, causes, control and mitigation measures of landslides. **Volcanoes** - Nature, types and extent of volcano, causes of volcanism, volcanic materials, geographic distribution of volcanoes.

UNIT-IV

Snow Avalanches: Origin and impacts. **Floods** – Type of floods, causes of floods, drainage basins, nature and frequency of flood, flood hydrographs, flood management and control. **Coastal hazards** - Cyclones, Tsunami, Tides and prediction and coastal zone management. **Drought:** Definition, types, assessment and mitigation; drought proofing. **Forest Fire:** Causes and consequences, monitoring and mitigation.

Text/References:

1. Roy, A.B. (2010). Fundamentals of Geology.Narosa Publishing House.
2. William H. Dennen and Bruce R. Moore (1986). Geology and engineering. WCB Publishers, Iowa.
3. Barbar W. Murk et. al., (1996). Environmental Geology, John Wiley & Sons, New York.
4. Singh Prabin (2010). Engineering and general geology.Kataria& Sons Publication.
5. Valdiya , K.S. (1982). Environmental Geology. Tata McGraw Hills Publication.
6. BimalKanti Paul (2011)**.** Environmental Hazards and Disasters-Contexts, Perspectives and Management, John Wiley & Sons, 332p.
7. Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed)(2013). The role of ecosystems in disaster risk reduction, *United Nations University Press.*
8. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

Course Code: EM-607 L: 4 T/P: 0 Credits: 4
Course Title: FUNDAMENTALS OF GEOINFORMATICS

UNIT-I

Remote Sensing Fundamentals

Introduction to geoinformatics, remote sensing, definition, physical basis of remote sensing, electromagnetic spectrum, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing, history of remote sensing. EMR interaction with earth surface materials, Spectral signatures of vegetation, water, soil, snow etc. in different regions of EMR, ground truth data collection; concepts in photogrammetry;

UNIT-II

Platforms and Sensors

Aerial and spaceborne platforms, orbits, sensors types – optical (multispectral, hyperspectral), thermal and microwave, resolutions, Landsat, SPOT, IRS, ERS, Radarsat, RISAT, and other operational remote sensing satellites.

Data Analysis

Visual interpretation – Scale, maps and map projections, interpretation keys; image characteristics, media and formats of digital images, image enhancement, image transformations, classifiers, classification – unsupervised and supervised, statistical separability, accuracy estimation, change detection, 3-D visualisation.

UNIT-III

Geographical Information System and Satellite based Navigation systems

Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, spatial database creation – digitization, scanning; processing of data, GIS implementation and project management. Commercial remote sensing and GIS softwares.

Satellite based navigation systems (GPS, Gallelio, Glonass, IRNSS): concepts and applications; Map projections and datums, coordinate systems; Survey of India topographical map types and numbering system.

UNIT-IV

Geoinformatics in Environment Management

Ecosystem inventory and monitoring – case studies on agriculture, forestry, wetlands, urban planning, snow and glaciers, coastal zone management, protected area management, climate change, air and water pollution; disaster management.

Text/References:

1. Joseph, George. 2005. Fundamentals of Remote Sensing, 2nd Edition. University Press India.
2. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India.
3. Jensen, John R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
4. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
5. Longley, Paul A., Michael F. Goodchild, David J. Maguire and David W. Rhind. 2005. Geographic Information System and Science, 2nd Edition. John Wiley and Sons.
6. Burrough, P.A. 2007. Principles of Geographic Information System. Oxford University Press.

Course Code: EM-609 L: 4 T/P: 0 Credits: 4
Course Title: ENERGY RESOURCES AND TECHNOLOGY

UNIT-I

Energy Fundamentals: Different forms of energy, Non-renewable and renewable energy resources, Concept of work and power; conductive, convective and radiant heat transfer, standard cycles, Energy UNITs.

Energy and Development: World energy scenario, Energy use in different sectors- Indian scenario, Energy and development issues, environmental implications, Need for new and alternate energy resources; Urban and rural energy use systems and patterns.

UNIT-II

Conventional Energy Sources and Technology : Resources and reserves ofCoal , petroleum , natural gas and lignite. Coal gasification and liquefaction, fluidized bed system and combined cycle system; Cracking of petroleum, petroleum products. Nuclear energy : Fission energy, fusion energy, Nuclear power generation- Fission reactors, Breeder reactors, Fusion technology, Nuclear energy issues. Magnetohydrodynamic power, principle of MHD generator, MHD equation.

UNIT-III

Renewable Energy Sources : Basic principles and harnessing of different alternate energy resources -Solar energy , Flat plate collectors, photovoltaic cells , Solar power; Wind energy, wind farms ; Geo-thermal energy ; Hydropower and micro-hydel power ;Tidal energy; Ocean Thermal Energy Conversion(OTEC) Technology; Hydrogen as alternate fuel.

Biomass energy, Energy plantations, Bioconversion technologies, biomass gasification for thermal, electrical and mechanical power generation, biomass gasifier systems, gasifier coupled dual fuel engine system, improved biomass cooking stoves.

UNIT-IV

Energy Conservation and Energy Economics : Principles of energy conservation, Energy efficiency at national level, improving energy efficiency, energy analysis, concept of exergy, (theoretical treatment), economic development and the environment, capital recovery factor, levelized annual cost, economic analysis of wind electric generation and thermal power systems.

Text/References:

1. Edward H. Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addition-Wesley Publishing Company, Reading.
2. Rakos Das Begamudre (2000), Energy Conversion Systems, New Age International Publishers, New Delhi.
3. C. S. Solanki (2009), Renewable Energy Technologies-A Practical Guide for Beginners, PHI Learning Pvt. Ltd., New Delhi
4. David Merrick and Richard Marshall(1981). Energy-Present and Future options, John Wiley & Sons, New York.
5. Y P Abhi and Shashank Jain (2006). Handbook on Energy audit and Environment Management, TERI, New Delhi
6. D. D. Mishra (2012) Energy, Environment, Ecology and Society, S. Chand & Company Ltd. New Delhi.

Course Code: EM-611 L: 4 T/P: 0 Credits: 4

Course Title: ENVIRONMENTAL STATISTICS

UNIT-I

An overview of environmental systems, Basic definitions and applications, Generation of environmental data; Types and objectives of environmental studies; Random processes, Stochastic processes in the environment; Significance / relevance of data analysis in environmental management.

UNIT-II

Sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data; Methods of data collection; Methods for selecting sampling locations and times; Simple random sampling, Stratified random sampling, Systematic sampling; Graphical representation by histogram, polygon and pie diagram.

UNIT-III

Measures of central tendency; Mean, median, mode; Sampling distributions of - Means, Difference of means, Proportion, Variances, Covariance; Estimation of parameters: Point and Interval estimates; Confidence interval estimation of - Means, Difference of means; Correlation and regression: positive and negative correlation and calculation of karlpearsons co-efficient of correlation; Linear regression and regression equation,Calculation of an unknown variable using regression equation; ANOVA, one and two way classification

UNIT-IV

Tests of Hypotheses: Null and Alternative Hypothesis; Type I and Type II Errors; Level of significance; Parametric tests (Concerning Means, Difference of means, Proportion, Variances): Tests of significance for large samples: Z test , Types of Z test (one sample and two sample) , Standard error for Z test ; Tests of significance for small samples: T-test (One sample, Two Sample: Independent and Dependent), Standard error for T-test ; F-test for comparison of variance ; Goodness-of-fit test – Chi-Square test; Test for quality of data: Qtest ; Nonparametric tests – Sign test, Wilcoxon Signed Rank test , Kruskal-Wallis te

Text/References

1. Joseph, A.J. (1997). Health, Safety and Environmental Data Analysis, Lewis Publishers, New York.
2. Pentecost, A. (1999). Analysing Environmental Data. Longman, London.
3. Gilbert, R.O. (1987). Statistical Methods for Environmental Pollution Monitoring, New York, Van Nostrand Reinhold.
4. McBeen, E.A. (1999). Statistical Procedures for Analysis of Environmental Monitoring Data.
5. Keith, L.H. (Ed.) (1988). Principles of Environmental Sampling ACS Professional References, American Chemical Society.
6. Berthouex, P.M. and Brown, L.C. (1994). Statistical for Environmental Engineers. Lewis Publishers, CRC Press.
7. Johnson, R.A. (1999). Miller & Freund's Probability and Statistical for Engineers (5th edn). Prentice-Hall of India Pvt. Ltd. New Delhi.
8. Walpole, R.E. and Myers, R.H. (1985). Probability and Statistics for Engineers and Scientists,3rd Ed. Macmillan Publishing Company, New York.

Practical: EM – 651 L: 0 T/P: 4 Credits: 2

Course Title: GEOINFORMATICS LAB

LIST OF EXPERIMENTS

REMOTE SENSING DATA HANDLING

1. Using Google Earth
2. Using Bhuvan
3. Software Demonstration
4. Data importing and visualisation
5. Geometric Correction
6. Image Enhancement
7. Georeferencing
8. Image Transformation
9. Visual Image Interpretation
10. Digital Classification (Unsupervised)
11. Digital Classification (Supervised)
12. Ground Truth Data Collection & Accuracy Assessment

SPATIAL DATABASE CREATION AND ANALYSIS

1. Using a GPS receiver
2. Digitization
3. Editing Vector Data
4. Attribute Data Management
5. Checking Data Quality
6. Query & Retrieval
7. Overlay Analysis
8. Change Analysis
9. Map Composition

Practical: EM – 653 **L: 0 T/P: 4 Credits: 2**

Course Title: ENVIRONMENTAL CHEMISTRY AND ENERGY LAB

LIST OF EXPERIMENTS

1. Determination of pH value of a given water sample.
2. Determination of Acidity of given water sample.
3. Determination of Alkalinity of given water sample.
4. Determination of Hardness of given water sample.
5. Determination of Chloride content in given water sample.
6. Determination of Dissolved Oxygen of given water sample.
7. Determination of Turbidity of given water sample.
8. Estimation of Calorific value of a sample of solid fuel using Bomb calorimeter.
9. Determination of Volatile matter in a given solid sample of Biomass
10. Determination of the mineral matter in given sample of Biomass
11. Determination of Ash content in the given sample of Biomass
12. Determination of fixed carbon in the given agro-waste residues
13. Estimation of Volatile matter in a given solid sample of Bituminous Coal sample
14. Estimation of the mineral matter in given sample of Bituminous Coal sample
15. Estimation of Ash content in the given sample of Bituminous Coal sample
16. Estimation of fixed carbon in the given Bituminous Coal sample
17. Experiments of Solar Energy

Practical: EM – 655 **L: 0 T/P: 4 Credits: 2**

Course Title: ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATION LAB

LIST OF EXPERIMENTS

1. To determine the descriptive statistics for the data set.
2. To construct Box plot, Individual value plot and histograms for the given data set and interpret the same.
3. To develop null and alternate hypothesis.
4. To understand the concept of standard error and confidence interval.
5. To understand sampling distributions and find central tendency.
6. To conduct one sample and two sample Z-test.
7. To conduct a t-test and interpret using standard values.
8. To conduct one sample T-test
9. To conduct two sample T test
10. To conduct a paired T-test to evaluate two test procedures and dependent data sets
11. To check for bias and significance of results for T-test
12. To carry out non parametric Mann Whitney Test for a sample.
13. To evaluate correlation between two parameters at various significance level.
14. To find a regressive coefficient and fit a linear model for a problem

Course Code: EM-602 L 4 P/T 0 Credits: 4
Course Title: AIR POLLUTION, METEOROLOGY AND CONTROL

UNIT-I

Introduction to Air Pollution: Over view of emissions, air quality and emission standards, air pollution standard index, criteria pollutants, sources and classification of air pollutants, effects of air pollution on human health, vegetation and property, primary and secondary air pollutants, global implication of air pollution (Greenhouse gases, ozone layer depletion, photochemical smog and ozone, acid rain).

UNIT-II

Air Pollution Meteorology Fundamentals: Meteorological scales of motion, environmental and adiabatic lapse rates, atmospheric boundary layer, pressure and temperature relationship in the lower atmosphere, vertical temperature variation, moisture, atmospheric stability and mixing height, temperature inversions, saturated lapse rate and cloud formation, adiabatic diagram, and wind roses.

UNIT-III

Atmospheric Diffusion Theory: Elementary overview of various atmospheric diffusion theories, steady-state atmospheric diffusion equation, diffusion models, wind speed change with elevation, Gaussian concentration distribution- Gaussian plume idea, Gaussian plume derivation as solution of the atmospheric diffusion equation, dispersion parameters in Gaussian models, Pasquill-Gifford Curves; Plume Rise –Momentum and Buoyant Plumes.

Sampling and Monitoring of Air Pollutants : Scope, purpose and objectives of air quality monitoring; preliminary survey required for planning an air quality survey; guidelines for planning a survey; design of an air quality surveillance network; sample size; theory and principles of instruments for measurements of – ambient air pollution; andstack monitoring.

Indoor air pollution: indoor air pollutants; indoor air quality model; infiltration and ventilation, control of indoor air quality.

UNIT-IV

Air Pollution Control Technologies: Stationery sources,air pollution control philosophies- emission standards, emission tax and Cost-benefit, general ideas in air pollution control, alternative control measures, low NO_X combustion, control of particulate contaminants, nature of particulate contaminants, PM_{10}, $PM_{2.5}$& PM_1 particle size distribution, distribution by mass and number, behavior of particles in the atmosphere, particulate control methods and devices: Wall collections devices-selection of particulate collection device, control of gaseous contaminants: gaseous control methods and devices – absorption, adsorption, flue gas desulfurization, combustion and condensation, control of mobile sources emissions.

Text/References

1. Arcadio P. Sincero., and Gregoria A. Sicero. (2010). Environmental Engineering: A Design Approach PHI Learning Pvt. Ltd, New Delhi
2. Seinfeld, J. H. (1986). Atmospheric Chemistry and Physics of Air Pollution, Wiley Inter-science, New York.
3. Stern, A. C. (2004). Air Pollution, Vol. 1-VIII, Academic Press.
4. M. N. Rao. (1993). McGraw Hill, McGraw Hill.
5. Bruno Sportisse (2010), Fundamentals in Air Pollution – From Processes to Modelling, Springer.
6. Perkins, H. C. (1974). Air Pollution, McGraw-Hill, New York.
7. J. W. Samuel., (1971), Fundamentals of Air Pollution, Samuel, Addison Wesley Publishing Company.

Course Code: EM-604 L 4 P/T 0 Credits: 4
Course Title: WATER POLLUTION AND WASTE WATER TREATMENT

UNIT- I

WaterSources: availability and quality of surface water and ground water, availability in India, impact of ground water development and depletion, status and trends of surface water utilization and consumption,

Water Pollution: Sources and types of water pollution, eutrophication, effects of various water pollutants, groundwater pollution, pollution of major rivers in India, National River Action Plan, Marine pollution, thermal pollution of water bodies.

UNIT-II

Water Treatment Technologies - Principle, application and design types;Water treatment flowsheet,Aeration, coagulation, flocculation, sedimentation; filtration; drinking water quality standards.Disinfection of water; Tertiary Treatment Techniques.

UNIT-III

Wastewater Treatment: Characterization, disposal standards, BOD growth curve, estimation of BOD rate constant by Thomas Slope method ; Self purification of waste in streams.Estimation of sewage quantity, flow variations, Conventional sewage treatment plant, flow sheet, dependence on flow conditions; Physical treatment processes- screen chamber, grit chamber, primary and secondary settling tanks, sludge drying beds, belt filter press, vacuum filtration

UNIT-IV

Biological treatment technologies: Aerobic and anaerobic processes, Operational principles and design of activated sludge process; trickling filter, Rotating Biological Contactors, extended aeration. Upflow anaerobic sludge blanket (UASB) reactors, Anaerobic fixed film bed reactor, anaerobic fluidized bed reactor; Sludge stabilization using anaerobic digestors.

Low cost technologies: Septic tank, Imhoff Tank, aerobic lagoons, Oxidation pond, High Rate Algal Ponds.

Text/References:

1. Metcalf and Eddy (2003). Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi.
2. Mark J. Harmmer, Mark J. Harmmer, Jr. (2009). Water and Wastewater Technology, 6th Ed. PHI Learning Pvt. Ltd., New Delhi.
3. Gilbert M. Masters and Wendell P. Ela (2009). Introduction to Environmental Engineering and Science, 3rd Ed., PHI Learning Ltd., New Delhi.
4. Qasim Syed R. (1999). Wastewater Treatment Plants: Planning, Design and Operation, 2nd ed., Technomic Publishing Co., Inc.
5. Garg S.K., (2014). Water Supply Engineering, 25th ed., Vol.1, Khanna Publishers.

Course Code: EM-606 L 4 P/T 0 Credits: 4
Course Title: BASIC AND APPLIED ENVIRONMENTAL MICROBIOLOGY

UNIT-I

Diversity of microorganisms, characteristics and environmental significance; Microbial growth and metabolism.

Microbiology of soil : Microbial habitats; Microbial interactions in soil; Microorganisms and biogeochemical cycles : Nitrogen transformations -Ammonification, Nitrification, Denitrification, Symbiotic and non-symbiotic nitrogen fixation; Carbon Transformations-Mineralization, microbial degradation of cellulose, hemicelluloses, lignin, chitin ; Microbial transformation of sulfur, phosphorus, iron and manganese.

UNIT- II

Aquatic and Aeromicrobiology: Microbial habitats and diversity in the aquatic environment, planktons, benthic microbes, Microbial mats, Biofilms, Indicator microorganisms, microbes and climate change mitigation. Aeromicrobiology, Important airborne pathogens; bio aerosols; bio-scrubbers and bio-filters;

UNIT -III

Microbial degradation and bio-transformation of xenobiotics ; Metal bioavailability; Microbial removal of toxic metals; Biomethylation of metals. Microbially induced corrosion; Acid mine drainage, microbial bioleaching of ores; microbial desulfurization of coal; microbially enhanced oil recovery.

UNIT-IV

Mycorrhizal diversity and interactions; Environmental applications of mycorrhizal associations; Soil biological control of plant diseases ; bio-fertilizers; bio-pesticides; Vermicomposting, Role of microbes in alternate energy generation; microbial fermentation; Role of microbes in effluent treatment; microbial recovery of vital elements.

Text/References:

1. Raina M. Maier (2008). EnvironmentalMicrobiology. Academic Press.
2. Pelczar, M.J.,E.C.S.Chan&N.R.Krieg, (1998). Tata McGraw Hills
3. Gabriel Bitton (1999). Wastewater Microbiology, 2nd Ed., Wiley-Liss, New York.
4. Nester, Roberts. (2009). Microbiology. Mcgraw Hill.
5. Black, Jacquelyn G. (2008). Microbiology: Principles and Explorations.Wiley.
6. Alan Scragg (2005). Environmental Biotechnology, 2nd Ed., Oxford University Press.
7. Mark Coyne (2001). Soil Microbiology: An Exploratory Approach. Thomson Business Information.
8. Gary W. Vanloon and Stephen J. Duffy (2000). Environmental Chemistry: A global perspective. Oxford University Press.
9. Alcano (2001). Fundamentals of Microbiology. Jones & Bartlett Publishers.
10. P.K. Mohapatra (2008). Textbook of Environmental Microbiology, I.K. International Pvt. Ltd.
11. Atlas, R.M. and R. Bartha (2000) Microbial Ecology: Fundamentals & applications. 4th Ed. Pearson.
12. R.Mitchell and Ji Dong Gu.(2010). Environmental Microbiology. Wiley Blackwell

Course Code: EM-608 L 3 P/T 0 Credits: 3
Course Title: SOLID AND HAZARDOUS WASTE MANAGEMENT

UNIT- I

Introduction: Definition, Sources and type based classification, Municipal soild wastes, industrial wastes and hazardous wastes, Environmental and health impacts due to solid wastes, Integrated solid waste management, Present scenario of MSW in India, **Properties of solid waste:** Physical and chemical composition of MSW, waste generation, factors affecting solid waste generation, waste reduction at source.

UNIT- II

Municipal solid waste management in India: Waste storage at source, Collection of wastes, Transfer and transportation of wastes, waste disposal, design specifications of waste storage bins, waste collection tools and transportation vehicles, Role of transfer stations, Prevalent SWM practices and deficiencies.

UNIT- III

Treatment (Processing) and Disposal techniques: **Composting-**Definition and principle, Aerobic composting, Anaerobic composting, Mechanical composting, Vermicomposting, Advantages and limitations of composting techniques. **Anaerobic digestion (Biogasification):** Definition and mechanism, Objectives and Development of biogas plants in India, Traditional digesters such as KVIC plant, Deenbandhu model, Emerging technologies. **Thermal Processing:** Incineration, Pyrolysis, gasification, RDF system, Merits and demerits of various methods. **Landfilling:** Planning and site selection, EIA of proposed site, Methods of site preparation, Land filling techniques, Landfill operations and maintenance, Leachate collection and treatment, Landfill gas emissions and methane recovery, Post-care closure and use of old landfills.

UNIT- IV

Hazardous waste management: Definition and characteristics, Sources and type based categorization, Treatment technologies: Physico-chemical, thermal, biological, sea and land disposal, Hazardous Waste (Management & Handling) Rules, Basel convention. **Biomedical wastes:** Definition, Sources, Generation, Segregation and storage of biomedical waste, Packaging, Handling and Transport of wastes, Treatment and disposal techniques, Biomedical Waste (Management & Handling) Rules. **E-Waste:** Definition and sources, Environmental and health impacts, Treatment and management, E waste (Management & Handling) Rules. **Radioactive wastes:** Types and sources, waste disposal techniques and management.

Text / References :

1. CPHEEO (2000).Manual on Municipal Solid Waste Management, Government of India, New Delhi,
2. Tchobanoglous G., Theissen H., and Eliassen R. (1991), *Solid Waste Engineering - Principles and Management Issues*, McGraw Hill, New York.
3. Peavy, A. S., Row, D. R., Tchobanoglous G. (1985). Environmental Engineering, McGraw Hill, Singapore.
4. Freeman H.M. (1988) Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw Hill. New York.
5. Ramachandra, T. V. (2011) Management of Municipal Solid Waste. TERI Press, New Delhi.
6. Papers published in various Journals & Magazines.

Course Code: EM-610 L 3 C/P 0 Credits: 3
Course Title: ENVIRONMENTAL POLICIES, ETHICS AND LEGISLATION

UNIT-I

International Environmental Laws: Evolution and development of International Environmental laws with reference to Stockholm Conference, Nairobi Declaration, Rio+5, Rio+10 (Johannesburg Summit), Rio+20 etc. Agenda-21, etc. Global environmental issues and laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste, CITES etc. Role of UN in protection of Global Environment, Multinational authorities and agreements.

Environmental Policies and Strategies in India: Principles of environment management, Evaluation of environmental policies and laws in India, regulatory agencies and their role in environment management, role of NGO, role of courts in environment protection, national and international conventions.

UNIT-II

Environmental legislation and policies: Duties and responsibilities of citizens in environmental protection, important legislations related to environment: Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974, Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Disaster management Act 2005, Trans-boundary Movement Rules, 2008. Plastics manufacture, Sale and Usage Rules, 1999. Coastal Regulation Zones (CRZ) Rules 1991. Rules, Regulations and Guidelines for Municipal Solid Waste, Electronic Waste, Industrial Location Policy. Bio-Medical Waste (Management and Handling) Rules, 1998, Green Tribunal Act, 2010, Coastal Zone Management Act 2009, Disaster management policy 2009, Amendments of Indian Acts & Rules, International environmental law and global issues.

UNIT-III

Pollution Prevention and Total Quality Environmental Management : Environmental indicators; ISOTC-207 standards; environmental audit; ISO 14000 series and environmental labeling. Cost benefit analysis, Environmental audit; Sustainable Development Tools and Life Cycle Assessment, Evolution of life cycle analysis (LCA); technical frame work for LCA; life cycle design; life cycle inventory and methodology with case study. Environment management techniques.

UNIT-IV

Environmental Ethics and Landmark Judgments: Value education and community, corporate social responsibility. Movements related to Environment – Sacred groves, Bishnoi tradition, Chipko movement, Tehri dam, SardarSarovar, Narmada dam, Almatti dam, Silent Valley.

Text / References:

1. Kulkarni, V. &Ramachandra, T.V (2011). Environment Management, TERI
2. Steven L. Erickson & Brian J. King (1999).Fundamentals of Environmental Management, John Wiley & Sons, New York,
3. Marry Ann Curran (1996). Environmental Life-Cycle Assessment, , McGraw Hill, New
4. Chirstopher Sheldon and Mark Yoxon, (1999). Installing Environmental Management Systems, Earthscan, London.
5. P. Sands (2003). Principles of International Environmental Laws, Cambridge University Press.
6. S. Divan and A. Roseneranz (1995). Environmental Law and Policy in India: cases, materials and statues, Oxford University Press.
7. G. Singh (2005). Environmental Laws in India, McMillan Publisher.
8. D. D. Basu(2003). Introduction to the Constitution of India, Wadhwa and Company Law Publisher.

Course Code: EMGE - 616 L 4 P/T Credits: 4
Course Title: ENVIRONMENTAL MODELLING

UNIT -I

Introduction : Environmental systems - an introduction; An overview of mathematical models applied to various environmental issues; Concept, need, scope and objectives of environmental modelling; Model classification – Brief review of different types of models: Mathematical (Deterministic), Numerical, Stochastic & Physical Models

UNIT- II

Air Quality Modelling : Air Quality Modelling – Historical perspective; Air quality models – objectives and aim of Modelling; Approaches to model building, elements of air quality models, classification of models; Gaussian Plume model – Point source models

UNIT-III

Water Quality Modelling

General: Water Quality Modelling – Historical Perspective; Water Quality Models and Water Resource Management systems.

Fundamentals of Water Quality Modelling: Mass Balance, Steady-State Solution, and Response Time; Control-Volume Approach ; Particular solutions; Completely mixed system - concept of continuously stirred tank reactors (CSTR) ; Different types of loading, Feedforward and feedback systems of reactors. Incompletely mixed system**:** Diffusion.; Distributed Systems (Steady-State); . Distributed Systems (Time-Variable).

UNIT -IV

Surface Water Quality Modelling*:* River and streams; Estuaries and Lakes; Dissolved Oxygen Models: DO sag model; BOD and Oxygen Saturation; Gas Transfer and Oxygen Reaeration; Streeter Phelps equation for point sources; Elements of Ground Water Modelling*:* Brief overview.

Text / References:

1. Thomann, R.V. and Mueller, J.A. (1987). Principles of Surface Water Quality Modelling and Control, Harper & Row, New York.
2. Chapra, S.C. (1997). Surface Water-Quality Modelling. McGraw-Hill International Edition.
3. Benarie, M.M. (1980). Urban Air Pollution Modelling (Cambridge, MA: The MIT Press)
4. Hipel, K.W. and Mcleod, A.I. (1994). Time series Modelling of Water Resources and Environmental Systems. Elsevier Science B.V. Amsterdam, Netherlands.
5. Zannetti, P. (1990). Air Pollution Modelling, Theories, Computational Methods and available Software.Van Nostrand Reinhold, New York.
6. Buonicore, A.J. and Davis, W.T. (1994). Air Pollution Engineering Manual.Air and Waste Management Association, New York, Van Nostrand Reinhold.
7. Turner, D.B. (1994). Workbook of Atmospheric Dispersion Estimates, 2nd ed., Ann Arbor, Michigan, Lewis Publishers.

Course Code: EMGE - 618 L 4 P/T 0 Credits: 4
Course Title: ECOTECHNOLOGY FOR ENVIRONMENT MANAGEMENT

UNIT-I

Systems approach, **S**ystems Theory application in ecosystems , ecosystem stability- resistance and resilience, ecosystem cybernetics, ecological modelling - Matrix Model, Compartment model, System transfer functions, mathematical and statistical models for ecosystem management.

UNIT-II

Emergent ecosystem properties governing sustainability, Application of ecotechnology for sustainable development and societal welfare; Ecosystem dynamics, Building resilience of ecosystems; soil stabilisation and soil fertility management, Ecological footprints ; eco-designing strategies.

UNIT-III

Ecorestoration principles and approaches, rehabilitation of salt-affected and water-logged lands, Riparian zone restoration; Phytoremediation technology for decontamination of industrially polluted sites by rhizofiltration, phytoextraction, phytostabilisation and phytotransformation; ecorestoration of mined areas.

UNIT-IV

Ecotechnology in industrial practices; Balancing inputs and outputs,Industrial metabolism, life cycle planning and eco-efficiency; Ecosystem based demineralization and decarbonation; constructed wetland technology: design and applications in wastewater treatment; Cradle to cradle approach for waste management. Green belts

Text/References:

1. Jørgensen, S.E (2012).Inroduction to Systems Ecology. CRC Press/ Taylor & Francis
2. Mitsch, W.J. and. Jørgensen, S.E. (1989). Ecological Engineering: An Introduction to Ecotechnology, John Wiley and Sons, Inc. New York
3. Kangas, P.C. (2004). Ecological Engineering: Principles and Practice. Lewis Publishers, CRC Press, Boca Raton, Florida.
4. Mitsch, W.J. and. Jørgensen, S.E. (2004). Ecological Engineering and Ecosystem Restoration" John Wiley and Sons, Inc., New York
5. Cairns Jr., J. (Ed.), 1994. Rehabilitating Damaged Ecosystems, Vol I. CRC Press
6. George Kvesitadze , GiaKhatisashvili , TinatinSadunishvili & Jeremy Ramsden. (2006). Biochemical Mechanisms of Detoxification in Higher Plants : Basis of phytoremediation , Springer
7. Robert H. Kadlec and Scott Wallace. (2005).Treatment Wetlands, 2nd Ed. CRC Press
8. R. Socolow (1994). Industrial Ecology and Global Change.Cambridge University Press
9. Wackernagel, M. and W. Rees. (1996). Our Ecological Footprint: Reducing Human Impact on the Earth. Gabriola Island, BC: New Society Publishers

Course Code: EMGE - 620 L 4 P/T Credits: 4
Course Title: ENVIRONMENTAL BIOTECHNOLOGY

UNIT-I

Introduction: Definition and importance of Environmental biotechnology, Biosensors in detection of environmental pollutants**:** Biomarkers, Biosensors of pollution- BOD, ammonia, methane.Role of microbes in sequestering carbon dioxide, Role of biotechnology in conservation of species**:** *in-situ* and *ex-situ* conservation through gene banks.

UNIT-II

Biodegradation: Recalciterance of xenobiotics, Biodegradation of Halogenated hydrocarbons, Substituted aromatic compounds, Polycyclic aromatic hydrocarbons, Pesticides, Surfactants. Emerging Environmental Biotechnologies**:** Application of microbial enzymes, Biomembrane reactors.

UNIT-III

Bioremediation of polluted environments: Environmental applications of bioremediation, types of bioremediation, mechanisms of microbial metal resistance and detoxification, microbial removal of radioactive elements, bioremediation of oil spills, limitations of bioremediation, bioremediation and genetic engineering. Biotechnology and radioactive pollution**:** Bioleaching; Biosorption and Biodepollution of soils contaminated by radio elements. Phytoremediation: Phytoremediation of xenobiotics and bioaccumulation of metals using plants.

UNIT-IV

Development of biodegradable and eco-friendly products: Fermentation technology; biomass production; Biofuel and Biodiesel-plant derived fuels, bioethanol, biohydrogen; biofertilizers; biopesticides; bio-polymers. Bioethics in Environmental biotechnology**:** Bioethics issues - Genetically engineered microbes and GM Crops.

Text / Reference:

1. A. Scragg. (2005). Environmental Biotechnology, 2nd Edition, Oxford University Press.
2. B. Rittman, P. L. McCarty. (2000) Environmental Biotechnology: Principles and
3. Applications, 2nd Edition, McGraw-Hill.
4. I. S. Thakur. (2006). Environmental Biotechnology: Basic Concepts and Applications. I K International Publications.
5. B.C. Bhattacharya and R. Banerjee (2007). Environmental Biotechnology. Oxford
6. University Press, 2007.
7. G. Bitton. (1999). Wastewater Microbiology, 2nd Ed., Wiley-Liss, New York.
8. J. M. Lynch, A. Wiseman. (1998). Environmental Bio-monitoring: The Biotechnology Ecotoxicology Interface, Cambridge University Press.

Course Code: EMGE - 622 L 4 P/T 0 Credits: 4
Course Title: AQUATIC ECOSYSTEMS AND WETLAND MANAGEMENT

UNIT- I

Land and Water Resource Management: Satellite missions for weather forecasting, monitoring and for conservation and management of natural resources. Remote sensing for mapping of origin and formation of differentlandform types (denudational, fluvial and coastal landforms). Assessment of soil degradation, desertification and mining impacts on land and bio-resources. Soil erosion vulnerability modelling. Remote sensing applications in air, surface and subsurface water resources evaluation, concept of hydrogeomorphological mapping and identification of ground water prospect zones.

UNIT- II

Bioresources Management and EIA: Remote sensing applications in agriculture, forest resources, afforestation activities, forest density mapping, biomass, volume, issues in forest management Forestfire modelling, wildlife mapping and habitat suitability assessment, carbon sequestration; wetland conservation and management; marine bioresources (fishes, aquatic weeds).Geospatial techniques in EIA and EMP preparation.Environmental assessment of ecologically disturbed areas. Water and Air Pollution studies.

UNIT- III

Urban Resource Management: Urban land use mapping, built environment, transportation network, utility-facility mapping, urban sprawl studies, site selection for urban development, Urban Information System.Urban Heat Island assessment and mitigation.

UNIT- IV

Disaster Management: Identification of suitable remote sensing data for disaster management studies. Studies related to landslides, earthquake, mining, volcanic, glacial and coastal hazards with case studies. Decision Support System for Disaster Management. Preparation of contingency planning during disasters and elements at risk mapping for urban disasters using earth observation data.

Books/References

1. George Joseph.(2005). Fundamentals of Remote Sensing. University Press (India) Ltd. Hyderabad.
2. P.A. Burrough. (2007). Principles of Geographic Information System. Oxford University Press, USA.
3. Chouhan, T.S. and Joshi, K.N. (1992). Remote Sensing for Natural Resources Management. Universal Scientific Publication, Jaipur.
4. Murk and Skinner. (1999). Geology Today- Understanding Our Planet, John Wiley and Sons Inc, New York.
5. John, R. Jensen, (2009). Remote Sensing of the Environment: An Earth Resource Perspective. Dorling Kindersley (India) Pvt. Ltd., NOIDA, India.
6. Davidson, Donald A. (1998). Soils and Land Use Planning, Longman, London.
7. A. Ganesh. (2006). Application of Geospatial Technology. Satish Serial Pub. House, Delhi.
8. Colwell, Robert W. (1971). Monitoring of Earth Resources from Aircraft and Spacecraft, NASA. Washington D.C.
9. Ester, J. and Senger, L.W. Tayler. (2001). Remote Sensing Techniques for Environment Analysis.

Course Code: EMGE – 624 L 4 P/T 0 Credits: 4
Course Title: GEOSPATIAL TECHNOLOGY FOR ENVIRONMENT MANAGEMENT

UNIT- I

Aquatic ecosystems: Definitions, Fresh water (lentic, and lotic), marine and wetland ecosystems, classification of aquatic ecosystems and wetlands; chemical composition of fresh and marine waters; ecosystem services and degradation.

Ecology of aquatic ecosystems: Elements of structure, functions and processes in fresh water (lakes and rivers), marine and estuarine ecosystems with respect to hydrology, and biodiversity;wetland soils types and redox potential; energy flow in aquatic ecosystems; stratification and zonation in rivers, lakes and oceans. Biological adaptations in plant and animals.

UNIT-II

Fresh water ecosystems-Lakes and reservoirs: Community organization, trophic levels and food webs; Bioassessment and biocriteria in lakes and reservoirs, index of biological integrity, eutrophication and trophic state index; nutrient dynamics, methanogenesis; ecology of constructed wetlands.

Rivers: Types of rivers, longitudinal profile and classification of drainage network, rivers and ecological continuum, riparian and flood plain wetlands; community organization; trophic structure and food webs; energy flow; negative and positive feedbacks and resilience.

UNIT-III

Marine & Estuarine ecosystems: Case I & II waters, estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, community organization, nutrient cycling and dynamics, upwelling and downwelling of nutrients; mangroves, coral reefs; Biodiversity in arctic and antartic oceanic environment.

UNIT-IV

Aquatic biodiversity, ecosystem services and restoration: Landscape ecological concepts; ecological restoration of fresh water and coastal ecosystems. Coastal regulation zone, International conventions& protocols: Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India. Remote sensing and GIS in aquatic ecosystem management, biodiversity conservation, climate change and aquatic ecosystem response.

Text/References:

1. M. Dobson (2000). Ecology of Aquatic Management, Pearson Education
2. Mitsch, W.J. and J.G. Gosselink (2015). Wetlands, 4th edition, John Wiley & Sons. 744p.
3. Van Der Valk, Arnold G., and Arnoud Van Der Valk (2012). The Biology of Freshwater Wetlands. Oxford University.
4. Raymundo E. Russo (2008). Wetlands: Ecology, Conservation and Restoration. Nova Science Publishers Inc. 446p.
5. Paul A. Keddy (2010). Wetland Ecology: Principles and Conservation. Cambridge University Press, 516p.
6. Walter K. Dodds (2002). Fresh Water Ecology-Concepts and Environmental Applications, Academic Press.
7. Peter Castro and Michael E. Huber (2003). Marine Biology. 4th Edition. Mc-Graw Hill.
8. http://www.ramsar.org

Course Code: EMGE-626 L: 4 T: 0 C:4
Course Title: WATERSHED MANAGEMENT

UNIT-I

WatershedDefinition and Scope

Watershed- Concept, watershed delineation from topographical maps, remote sensing and GIS in watershed mapping,watershed problems, geo-morphological characteristics of watershed, types of watershed, objectives of watershed management and development, field data collection.

UNIT-II

Watershed characteristics

Landuse, vegetation, drainage, drainage morphometry, climate, soil, geology, slope and aspect, land capability classification, types of erosion, estimation of soil loss,erosivity index,Universal Soil Loss Equation (USLE).

UNIT- III

Watershed Hydrology

Concept of hydrology, hydrological cycle and its components; geohydrology, hydrometeorology, analysis of precipitation data, evapotranspiration, surface run-off; rainfall-runoff relationship, stream flow estimation, concept of hydrograph; sediment load, types and methods of measurement.

UNIT- IV

Watershed Planning and Management

Multi objective planning, watershed restoration, Resource Use pattern,people participation, landuse practices, watershed prioritization, integrated watershed development, monitoring and evaluation of watershed management activities, economics of watershed protection, climate change adaptation in watershed

Case studies: Success stories of watershed management in India

Text/Reference

1. Watershed Planning and Management (2000)- Rajvir Singh, Yash Publication House, Bikaner-India
2. Land and Water Management: VVN Murthy- Kalyani Publishers, New Delhi.
3. Integrated Watershed Management: Principles and Practice (1988) - Heathcote, I. W. John Wiley and Sons, Inc., New York.
4. Hydrology: Principles, Analysis and Design (2007) - H. M. Ragunath, 3rd edition, New Age International, New Delhi.
5. Land and Water Management (2009)- VVN Murty and MK Jha, 5th edition, Kalyani Publishers, New Delhi.
6. Hydrology, Soil Conservation and Watershed Management- Ghanshyam Das, PHI, New Delhi.
7. Soil and water Conservation Engg (2009)- R. Suresh, 2nd revised edition, Standard Publishers Distributiors,1705B, NaiSarak, Delhi

Course Code: EMGE – 628 L 4 P/T 0 Credits: 4
Course Title: ESSENTIALS OF URBAN FORESTRY AND BIODIVERSITY

UNIT-I

Concepts: Urban greens, landscape, urban forestry and biodiversity, Indian and global perspectives of urban forestry. Human dimensions of urban forests - Migration, Urban poverty and livelihood.Environmental problems in urbanizing world.Ecological, social, economic, health, cultural, recreation values of urban green space.Benefits of linking forest and vegetation with urban planning.Contribution of urban forests in generating livelihoods for urban poor in India.Concept of sustainable cities, Smart cities and green space.

UNIT-II

Urban biodiversity: Floral and faunal diversity in urban landscape. Urban trees and shrubs. Threats and significance of Urban biodiversity in India. Characteristics of selected urban forestry species. Significance of biodiversity parks. Design wildlife habitat. Climate change affect and urban vegetation. Preparation of urban biodiversity register (UBR). Monitoring the loss of Urban Biodiversity.Strategy for Urban biodiversity planning, conservation and development.

UNIT-III

Management of urban forest landscape: Urban landscape elements. Species choice for Urban forestry. Technical aspects of tree maintenance-pruning, cleaning, post plantation care, cleaning, nursery, water management. Types of plantation, design & tree architecture, monitoring, urban forestry management issues, stake holder's analysis.

Case study of Urban area restoration- waterbody and wasteland.

UNIT-IV

Urban forestry planning policy and application: Integration of urban forestry in city planning, institution policy and social issues, incentives and partnerships. Role of government, NGOs, corporate houses and civil society organizations in urban green space development, Public, private partner (PPP) model.

Case study of Urban Green Space Management in Cities-New Delhi, Hyderabad, Bangalore

Synthesis and directions for future research, planning and implementation in urban forestry and biodiversity.

Text/References:

1. Grey, G.W., and F.J. Denke. (1986). Urban Forestry. Wiley Publication.
2. Miller, R.W. (1997). Urban Forestry: Planning and Managing Urban Green Spaces, 2nd edition. Prentice Hall.
3. Konjendijk, et al. (2005). Urban Forests and Trees. Springer.
4. Kuchelmeister, G. (1998). Urban Forestry in the Asia – Pacific Region: Status and Prospects. APFSOS Working Paper #44, Food and Agriculture Organization.
5. Bradley, Gordon A., (editor) Urban Forest Landscapes: Integrating Multidisciplinary Perspectives.

Practical: EM – 652 **L: 0 T/P: 4 Credits: 2**

Course Title: ENVIRONMENTAL MICROBIOLOGY LAB

LIST OF EXPERIMENTS

1. To study the sterilization techniques and Introduction to various types of laboratory equipment used to isolate and maintain microbes.
2. Introduction to Microscope.
3. To prepare nutrient agar and nutrient broth media for the culture of microorganisms.
4. To prepare agar slants and agar plates.
5. To determine the culture characteristics of micro-organisms as an aid in identifying and classifying organisms into taxonomic groups.
6. To isolate microbial colonies present in a mixed culture by streak plate methods & to obtain a pure culture.
7. To determine the rate of growth of bacteria in liquid media.
8. To prepare a culture of soil micro-organism & count the number of bacterial colonies.
9. To identify microbial specimen using permanent slides.
10. To prepare the culture of waste water micro-organism and to enumerate them.
11. Removal of azo dye by using *Phanerochaetechryosporium.*
12. To perform differential staining between the two principle groups of bacteria.
13. To determine the presence of coliform bacteria in a given water sample using MPN Method.
14. Bioremediation of phenol from wastewater.

Practical: EM – 654 **L: 0 T/P: 4 Credits: 2**

Course Title: AIR AND WATER POLLUTION LAB

LIST OF EXPERIMENTS

1. To study principle, components and working operation of respirable dust sampler.
2. Determination of NOx from ambient air using Respirable dust sampler/High volume sampler.
3. Determination of level equivalent values at a given place using Sound Level Meter.
4. Determination of Sox from ambient air using Respirable/High volume sampler
5. Determination of RPM & TSPM from ambient air using Respirable dust sampler.
6. Estimation of chlorides in water sample by Mohr's method.
7. Determination of Chemical Oxygen Demand (COD) in waste water.
8. Determination of Biological Oxygen Demand (BOD) of waste water.
9. Estimation of Sulphate in water sample by spectrophotometric method.
10. Estimation of Phosphate in water sample by spectrophotometric method.
11. To study principle, components and working operation of stack monitoring kit.
12. Estimation of Nitrate in water sample by spectrophotometric method.
13. Estimation of Fluoride in water sample by SPADNS method.
14. Estimation of Total Solids and Total Dissolve Solids in water sample
15. Determination of Total Kjheldahl Nitrogen
16. Estimation of Nickel, lead and copper in water samples by AAS.
17. Determination of the concentration of Oil & Grease in given water sample.

Course Code: EM – 701 L 4 P/T Credits: 4
Course Title: ENVIRONMENTAL IMPACT ASSESSMENT & RISK ANALYSIS

UNIT-I

Introduction to EIA: Definition , scope and development of EIA, purpose, objectives and basic principles of EIA, Types of EIA, Strategic environmental assessment(SEA); History of EIA in India - EIA Gazette Notification, 1994 & 2006 - CategoryA & Category B Projects, Prior Environment clearance(EC) requirements and stages.General EIA methodology; Establishing the environmental baseline.

UNIT-II

EIA methodology : Screening- criteria, siting guidelines, prohibited zones; Scoping: Identification of Valued Environmental Components (VEC), ImpactIdentification -Checklists, matrices, qualitative methods, networks and overlay maps; Impact prediction- prediction models for impacts on air, water, soil and biological environment , Impact evaluation -multi attribute utility theory, environmental evaluation system- Cost benefit analysis, Economic valuation of intangible environmental impacts, Social impact assessment

UNIT-III

Impact mitigation, monitoring & audit: Mitigation methods and approaches, Appraisal, review, Decision making, Public consultation and participation,monitoring and auditing in EIA process, various forms of audit, Environment management plan (EMP), Environmental Impact Statement (EIS), Post-clearanceMonitoring Protocol.Comparison of EIA in different countries

Case studies:EIA of thermal power plant, pulp and paper mills, river valley projects, mining projects, urbanization and linear development.

UNIT-IV

Risk analysis andEnvironmental management: Definition of risk, environmental risk analysis, fundamentals of hazard, exposure and risk assessment, basic steps in risk assessment, hazard identification, dose response assessment, risk characterization, quantified risk assessment for industrial accidents, design of risk management program, risk assessment application to environmental management problems.

Recommended Books:

1. John Glasson, RikiTherivel and Andrew Chadwick. 2005. Introduction to Environmental Impact Assessment, 2nd Ed., UCL Press, Philadelphia, USA
2. Canter, Larry W. 1996. Environment Impact Assessment. McGraw-Hill.
3. Rau, G.J. and C.D. Weeten. 1980. Environmental Impact Analysis Handbook McGraw Hill.
4. D. P. Lawrence. 2003. Environmental Impact Assessment, Practical Solutions to Recurrent Problems, John Wiley and Sons.
5. Y. Anjanvelu. 2002 Environmental Impact Assessment Methodologies, B.S.Publications,
6. D. P. Lawrence, 2003. Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons.
7. Eccleston, C.H. 2011. Environmental Impact Assessment, Taylor & Francis
8. Peter Wathem 2013. Environmental Impact Assessment : Theory and Practice , Taylor & Francis

Course Code: EM – 703 L 4 P/T 0 Credits: 4
Course Title: ECOSYSTEM MANAGEMENT AND RESTORATION

UNIT- I

Ecosystems degradation and restoration needs: Overview of ecosystem ecology, ecosystem disturbances and degradation; Ecosystem services and their valuation; The Economics of Ecosystems and Biodiversity (TEEB); importance of ecological restoration; trajectory of ecosystem restoration; Dimensions in restoration ecology-species, communities, ecosystems, landscapes; succession and restoration.

Landscape elements and ecosystems: Island biogeography theory; patch, matrix and corridor model of landscapes; scale, heterogeneity, patterns; fragmentation; flows between landscape elements and ecosystems; geospatial tools for landscape level studies.

UNIT- II

Ecosystem Management for restoration: Ecosystem services *vis a vis* ecosystem biodiversity and functions; ecosystem integrity and health; Ecosystem management- principles, guidelines and applications; ecosystem approach for environment management; Geospatial techniques in ecosystem management; relevance and applications of landscape ecology in ecosystem management ecosystems.

UNIT- III

Restoration tools and methods: Planning and implementation framework; adaptive management and monitoring; steps for restoring an ecosystem; prioritization of restoration actions: restoring and maintaining ecosystem services- soil ecology, biological diversity, hydrology, habitat loss, watersheds; measurement of restoration success; geospatial techniques in restoration and sustainable development.

UNIT- IV

Application of ecological restoration techniques to:

Lakes and wetlands; Rivers, streams and floodplains; Urban areas; Coastal ecosystems; Forest ecosystems; Mining sites and ecologically disturbed areas; Desertic and degraded soils; biodiversity conservation; animal restoration and reintroduction; sustainable development; climate change and ecosystem restoration.

Text/References

1. D. Matlock, Robert A. Morgan (2011). Ecological engineering design: restoring and conserving ecosystem services, John Wiley & Sons, Inc, 339p.
2. Martin R. Perrow, Econ and Anthony J. Davy [Ed] (2002), Handbook of Ecological Restoration, Volume 1 and 2, Cambridge University Press.
3. Sven Erik Jorgensen [Ed] (2009). Applications in Environmental Engineering, Elsevier B.V. Radarweg, Amsterdam, The Netherlands, 380p.
4. Ecological Restoration (2008). A Source Book for Ecological Restoration, Foundation for Ecological Security, 104p.
5. Pirot, J.-Y., Meynell P.J. and Elder D. (2000). Ecosystem Management: Lessons from Around the World. A Guide forDevelopment and Conservation Practitioners. IUCN, Gland, Switzerland and Cambridge, UK. x + 132 pp.
6. Jelte van Andel and James Aronson (editors) (2006). Restoration ecology : the new frontier, Blackwell Publishing, 319p

Course Code: EM – 705 L 3 P/T Credits: 3
Course Title: INDUSTRIAL POLLUTION PREVENTION AND CONTROL

UNIT- I

Types of industrial pollutants, Industrial wastewater characterization, List of green, orange and red industries, Standards of disposal of industrial wastes, MINAS, Industrial Estate planning.

UNIT- II

Methods of volume and strength reduction, Process and equipment modification, Segregation, Reuse, Recycle, Good housekeeping practices, Conservation, Adoption of cleaner production technologies, Neutralization, Equalization, Proportioning.

UNIT -III

Specific treatment technologies: Oil and Gas removal, Cyanide removal, Nitrogen and phosphorus removal, VOCs removal.

CETP: Requirement and objectives of CETP, Planning and management of CETP facilities for small-scale industries, Institutional deficiencies, Current scenario of CETPs in Delhi-A case study.

UNIT- IV: Manufacturing process description, Waste/emission generation sources, Waste characteristics, Pollution prevention options and treatment for the following industries:

1. Sugar
2. Distillery
3. Pulp and Paper
4. Fertilizer
5. Oil refineries
6. Cement
7. Tannery
8. Dairy
9. Textile
10. Pharmaceutical
11. Iron and Steel

Text / References

1. Ecrenfelder W.W. (1990), Industrial Pollution Control, McGraw Hill Int. Ed.
2. Metcalf & Eddy Inc. (2002). Wastewater Engineering Treatment and Reuse 4th Ed. Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Nemerow, N. L. (1978). Industrial Water Pollution: Origin, Characteristics and Treatment. Addison- Wesley Publishing Company, New York.
4. Patwardhan, A. D. (2012) Industrial Waste Water Treatment, PHI Learning Pvt. Ltd. New Delhi.
5. Khitoliya, R. K. (2014) Environmental Pollution: Management and Control for Sustainable Development. 2nd Ed. S. Chand publication, New Delhi
6. CPCB publications
7. Papers published in various Journals & Magazines.

Course Code: EM – 707 L 3 P/T Credits: 3
Course Title: ENVIRONMENTAL HEALTH AND SAFETY

UNIT-I

Environment Health: Basic Principle of Environment Health, Definition and dimensions, Indicator of health, Health Programme in India, Physical response of man to relevant stress in the environment. Biogeochemical factors in environmental health, epidemiological issues-goitre, fluorosis, arsenic poisoning, Global Health Programmes.

UNIT-II

Causes and effects of pollution: Industrial Toxicology- Study of environmental dose effect relationships. Evaluation of toxicity and threshold limits; health hazards associated with some important industries; Occupational health hazards: Pneumoconiosis, Silicosis, Anthracosis, Asbestosis. Hazards associated with radiological environment; natural and man-made radiations; Acute and delayed cellular effects by radiation, radiation syndromes, chromosomal aberrations.

UNIT -III

Transmissible diseases: Symptoms, epidemiology and control of vector borne diseases-amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis. Waterborne diseases: Jaundice & diarrhea. Principles of toxicology: Toxic chemicals in the environment and their effects: effects of heavy metals, Pesticides. Mode of entry of toxic substances, biotransformation of xenobiotics, detoxification, indices of toxicology. LD50: Definition and uses, Dose response curve, Probit Factor. Carcinogens and Mutagens.

UNIT- IV

Environment Health Management: Health ecology, Analysis and recommendations regarding health and safety problems in the working and living environment with Biostatistics and epidemiological analysis.

Occupational and industrial hygiene technology- illustrating the principles, methods of recognizing evaluating and controlling environmental hazards, Health and safety policies: Occupational Safety and Health Act, Safety Standards, Role and responsibilities of different organisations in environment health and safety management.

Text/References

1. R.B. Philp., (1995). Environmental Hazards and Human Health. CRC Press Inc., Boca Raton, Florida.
2. M.T. Morgan., (2002). Environmental Health. 3rd ed. Brooks Cole Publication.
3. J.E. Park and K. Park, (1986). Textbook of Preventive and social Medicine, Banarsidas Bhanot publication.
4. R. Niesink, M. A. Hollinger, J. De Vries., (1996). Toxicology – Principles and Applications, CRC Press.
5. J. E. Alleman and J. T. Karanagh., (1982). Industrial Waste, Ann Arbor Science.
6. K. Herman and M. Bisesi., (1999). Handbook of Environmental Health and Safety, Jaico Publishing House, Delhi.

Course Code: EM – 709 L 3 P/T Credits: 3
Course Title: ENVIRONMENTAL INSTRUMENTATION

UNIT-I

Photometry: Introduction to Chemical Instrumentation analysis, Advantages over classical methods, Classification; Spectro, Electro analytical and Seperative methods, Laws governing PhotometryBeer's and Lambert's Law). Colorimeters, Spectrophotometers(UV-Visible), Monochromators, filters, grating, prisms, Single wavelength and single beam monochromatic systems , Dual wavelength and double beam monochromatic system, Principles of IR spectrophotometer

UNIT-II

Flame and Atomic Absorption Spectrophotometer: Flame photometry; Principle, Construction details, fuel gases, atomiser, burner , optical system , recording system. Atomic absorption spectrophotometer; Theoretical concepts, Instrumentation, Hollow cathode lamps, Burners and flames, Plasma excitation sources, optical and electronic systems

UNIT-III

Fundamentals of Chromatography: General description, definition, terms and parameter used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase nature of adsorbents , Rate theory , Band broadening: Eddy diffusion , Methodology for selection of stationary phase.

UNIT-IV

HPLC AND GC: High pressure liquid chromatography; Apparatus , Pumps, Column packing, Characteristics of liquid chromatography, detector; UV, IR , Refractometer and fluorescence detector. Gas Chromatography; Principle, Comparison of GSC and GLC instrumentation, Columns packed and tubular study of detectors , thermal conductivity, flame ionisation , electron capture and mass spectrophtometry, factors affecting and separating applications

Calibration of analytical instruments, use of reference materials and certified reference materials; statistical evaluation of measurement data and uncertainty estimation.

Text / References

1. D.A. Skoog,(2000), Principles of Instrumental analysis, fifth edition , Saunders college publication
2. D.H.Williams and J.Fleming (1995). Spectroscopic methods in organic chemistry, Sixth edition , McGrawHill
3. B.K. Sharma (2007), Instrumental methods of chemical analysis, Krishna Prakash Media
4. J.Willard. (1999). Instrumental methods of analysis,7th Edition , CBS publishers

Practical: EM – 751 **L: 0 T/P: 4 Credits: 2**

Course Title: ECOLOGY AND ECOSYSTYEM RESTORATION LAB

LIST OF EXPERIMENTS

1. Monitoring site characteristics
2. Using a GPS receiver
3. Population and density estimation
4. Quadrat Sampling – Size and Numbers
5. Community Structure and vegetation indices
6. Forests/trees : Tree diameter, DBH, basal area, height
7. Forests/trees: Timber volume, growth, age
8. Soil Analysis: composition (particle size), density
9. Soil: Nutrients (P, N, C)
10. Wetlands: delineation of wetland boundaries based on Remote sensing data
11. Determination of habitat types and qualitative turbidity on satellite imagery
12. Wetland hydrology: area, depth, volume
13. Soil organic Carbon determination
14. Hydrophytic plants and functional groups
15. Productivity assessment in aquatic ecosystems

Visit to ecorestoration sites: Yamuna Biodiversity Park, HauzKhas lake; Asola-Bhati mines; Aravali Biodiversity Park (one or two)

Practical: EM – 753 **L: 0 T/P: 4 Credits: 2**

Course Title: ENVIRONMENTAL INSTRUMENTATION LAB

LIST OF EXPERIMENTS

1. Determination of trace metals such as Calcium in aqueous sample using Flame Atomic Absorption Spectrometer
2. Determination of trace elements in aqueous sample using Flameless or graphite furnace Atomic Absorption Spectrometer
3. Determination of Heavy metals through Vapor Gas Assembly
4. Analysis of organic contaminants using Gas Chromatograph and interpretation of data.
5. Reverse phase chromatography -HPLC
6. Normal Phase chromatography - HPLC
7. Metal analysis using double beam UV-VIS spectrophotometer.
8. Determination of Na and K using Flame Photometer.

Course Code: EMOE - 731 L 4 P/T Credits: 4
Course Title: CLIMATE CHANGE MITIGATION AND ADAPTATION

UNIT-I

Basic concepts and mechanisms: Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El-Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action. **Effects:** Rise in earth's temperature; effects on forests, agro-ecosystems; desertification, freshwater ecosystems, oceans; sea level rise; melting of polar ice and glaciers; rainfall patterns; extreme events, socio-economic and public health consequences.

UNIT-II

Climate Change Policy-Mitigation: Carbon storage and sequestration, carbon management through biotic sequestration-forests, wetlands; soil carbon sequestration oceanic and geologic injection, scrubbing and mineral carbonation; bio fuels, carbon farming and carbon trading

UNIT-III

Climate Change Policy – Adaptation: Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation, measurement of adaptation cost; issues in financing adaptation; case studies; **Indian scenario**: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).

UNIT-IV

International response: Intergovernmental Panel for Climate Change (IPCC) and its role; United Nations Framework Convention on Climate Change (UNFCCC), CDM and Kyoto Protocol; Bali road map; The Copenhagen Accord; future actions; ethics of climate change.

Text/References

1. J. T. Hardy (2003). Climate Change: Causes, effects and solutions, John Wiley and Sons
2. Egbert Boeker and Rienk van Grondelle (2013). Environmental Science- Physical Principles and Applications, John Wiley & Sons, Ltd.,New York
3. Toman, M.A., U. Chakravorty, and S. Gupta, India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country, RFF Press, 2003.
4. AkimasaSuni, Kensuke, F., and Ai, Hiramatsu.(2010). Adaptation and mitigation strategies for climate change. Springer.
5. Ravindranath,N.H., Ravindranath, N. and Sathaye, J.A.(2002). Climate change and developing countries.Kluwer Academic Publishers.
6. Burroughs, W.J. (2007). Climate change: A multidisciplinary approach (2nd edition.). Cambridge University Press. Dash,
7. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India. New Delhi.
8. IPCC,(2007): Summary for policymakers. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK, 7- 22.

Course Code: EMOE - 733 L 4 P/T 0 Credits: 4
Course Title: DISASTER RISK REDUCTION AND MANAGEMENT

UNIT- I

Introduction: Concepts and definitions of Hazard, disaster, vulnerability, resilience, and risks; classification of disasters; brief introduction of Geological Disasters, Hydro-Meteorological, Biological, Technological and Man-made Disasters; Global Disaster Trends – Emerging Risks of Disasters; Climate Change and Urban Disasters.

UNIT- II

Disaster Management Cycle, Risk Reduction and managing risks: Disaster Management Cycle; Principles of risk management, hazard and vulnerability mapping and analysis (physical, social, organizational, economical, technological). Developmental projects (dams, power plants etc.) and risk management; Evacuation, Communication, Search and Rescue; Emergency Operation Centre – Incident Command System; Relief and Rehabilitation; Post-disaster Damage and Needs Assessment; Restoration of Critical Infrastructure; Reconstruction and Redevelopment;

UNIT- III

Disaster Risk Reduction tools and capacity building: Prevention and Mitigation of Disasters, Early Warning System; Preparedness; Geoinformatics in Disaster Management (RS, GIS, GPS); Disaster Communication Systems (Early Warning and Its Dissemination); Disaster safe designs and constructions; Disaster Risk Transfer and Financing; role of print and electronic media during disasters. Community based disaster risk reduction. Health issues and hospital preparedness and response; System approach in disaster management;**Disasters and Ecosystems:** Climate change and ecosystems based management for disaster risk reduction and resilience; Land Use Planning and Development.

UNIT- IV

Disaster Management in India: Disaster Management in India; Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; Role of Government, Non-Government and Inter-Governmental Agencies; National Disaster Management Authority (NDMA); NIDM (National Institute of Disaster Management), State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; International Agencies (International Space Charter, UNISDR); International Strategy for Disaster Reduction; Hyogo Framework (2005-2015); Senedai Framework (2015-2030).

Text/References

1. Bimal Kanti Paul (2011)**.** Environmental Hazards and Disasters-Contexts, Perspectives and Management, John Wiley & Sons, 332p.
2. Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed)(2013). The role of ecosystems in disaster risk reduction, UNITed Nations University Press.
3. Govt, of India (2005). Disaster Management Act 2005.
4. Jack Pinkowski (Ed.) (2008). Disaster Management Handbook, CRC Press -Taylor & Francis Group, 595p.
5. Thomas D. Schneid and Larry Collins (2001).Disaster Management and Preparedness, Lewis Publishers, 247p.
6. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

Course Code: EMOE – 735 L 4 P/T 0 Credits: 4
Course Title: URBAN BIODIVERSITY STRATEGIES FOR CONSERVATION

UNIT-I

Urban Ecosystem: An Introduction to Novel ecosystems in the Anthropocene, Urban Ecology. Cities as Human and Ecological Systems, Global and Local Patterns of Urbanization: Exo-urbanization, Suburbanization, New town , Disurbanization (or counterurbanization) , Reurbanization, Slums, Shanty Towns, Urban climate and climate change- Urban Soil and Water, Heat Island Effect. Social and ecological urban systems.

UNIT-II

Urbanization and Biodiversity: Biogeography and biodiversity of anthromes and novel ecosystems, Biodiversity within urbanized areas, Urban Ecosystem Services, Impacts of Urbanization on Biodiversity, Positive Impact on Biodiversity, Extinction and urbanization, Urban Species and Communities: Native Species , Non-native species Urbanophilic, Urbanophobic, Synanthropic, Archaetypes, Neotypes, Impacts of Non- native/invasive/exotic species, Biotic Homogenization and Differentiation.

UNIT-III

Conservation in Urban Areas: Urban Planning and Restoration, Reconciliation ecology**,** Urban planning and green infrastructure: Green Roofs, Green Spaces, Gardening/Landscaping, Living Walls, Vertical Gardening, Singapoe/City Biodiversity Index, Biophilic Cities, Resilient Cities, Sustainable Cities, Green Delhi Movement in NCT of Delhi.

UNIT-IV

Urbanization and Human Well Being Convention On Biodiversity and Conservation: National Biodiversity Strategy and Action Plan, Local Biodiversity Strategy and Action Plan Guidelines, Diseases in urban Environment, Shaping cities for health: complexity and the planning of urban environments in the 21st century, Cities and Biodiversity Outlook Assessment Report, Conservation Education, Conservation and Society, Future Strategies for Urban Biodiversity.

Text/References

1. Hobbs, R. J., E. S. Higgs, and C. M. Hall, (eds. 2013). Novel ecosystems: intervening in the new ecological world order. John Wiley & Sons, Chichester, UK.
2. Chichester, UK.Hobbs, R. J., E. Higgs, and J. A. Harris. (2009). Novel ecosystems: implications for conservation and restoration. Trends in Ecology & Evolution 24:599-605.
3. Alberti et al. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. Bioscience 53(12): 1169-1179..
4. Adams LW. (1994).Urban Wildlife Habitats. Minneapolis: University of Minnesota Press.
5. Gilbert OL. (1989). The Ecology of Urban Habitats. London: Chapman and Hall.
6. Hughes J., Pretty J., Macdonald D.W. (2013). Nature as a source of health and well-being: is this an ecosystem service that could pay for conserving biodiversity? In: Key Topics in Conservation Biology (eds. D.W. Macdonald, K.J. Willis). John Wiley & Sons Ltd, Chichester

Course Code: EMOE – 737 L 4 P/T 0 Credits: 4
Course Title: HUMAN ASPECTS OF BIODIVERSITY AND ENVIRONMENT

Unit I

Linking biodiversity, environment and human being: Basic concept of biodiversity and environment: Biotic and abiotic factors, biodiversity and its components; How biodiversity and environment affects human well-being: case studies from historical perspectives and current scenario; Factors that affect human perceptions about biodiversity and environment

Unit II

Understanding human aspects of biodiversity and environment: Socio-cultural diversity, ethnic diversity, linguistic diversity; Sacred groves and sacred landscapes; Understanding ecological services; Effect of local biodiversity and environment on human life (wrt local plants and animals, pesticide use vs agricultural pests, handling native vs. exotic sp, urban biodiversity and urban planning). Understanding different missions related to human aspects of biodiversity and environment: **'Swachh Bharat Abhiyan', 'Clean Ganga'and 'Clean-Yamuna'campaign,'Save Tiger', 'Save Vulture', 'Save Forest'**, 'Protect Wetlands' '**Decade**on**Biodiversity'**.

Unit III

Concepts and applications related to human aspects of biodiversity and environment

Concept of Indigenous Knowledge Management and benefit sharing with case studies; Biomimicry; Ecotourism and Eco-taxation; Eco-designing, Conservation education, Environmental journalism

Unit IV

Addressing issues related to human aspects of biodiversity and environment

Ethical issues related to biodiversity and environment; Pro and cons of ban on animal dissection; Issues related to GM crops and Vertebrate pest management; Practising sustainability for a better future

Books/References

1. Miller, G.T. and Spoolman, S. (2011). Living in the environment. Cengage Learning.
2. Pearce, D.W. and Moran, D. (1994). The Economic Value of Biodiversity. Earthscan Publishers.
3. Wood, P.M. (2000). Biodiversity and democracy: rethinking society and nature. University of British Columbia Press.
4. Groom, M.J., Meffe, G.R. and Carroll, C.R. (2006). Principles of Conservation Biology.Sinauer Associates, Inc., USA.
5. Primack, R. (2006). Essentials of Conservation Biology. Sinauer Associates, Inc., USA.

Course Code: **EMOE 739** **L 4 P/T 0 Credits: 4**

Course Title: **Corporate Social Responsibility**

UNIT-I

Concept of CSR: What do you mean by CSR? New Company Law in India: Doing Business with the Compulsory CSR. Business ethics and society in India, role of public policy in promoting CSR and sustainability, benefits of CSR programme; global principles and guidelines; The Companies Act, 2013 critical analysis, disclosure of CSR activities made compulsory, Mutual Co-existence: CSR and ensuring environmental sustainability.

UNIT-II

Scope of CSR across key sectors

Rural development and CSR,CSR initiatives being taken by selected public and private Indian companies for rural development;The Impact of CSR Programs on socio-economic development of Rural Poor.Greening environment.Role of NGOs and community. Health care development and CSR, CSR initiatives being taken by selected public and private Indian companies;The Impact of CSR Programs for clean India mission. Role of CSR in the area of Education, CSR initiatives being taken by selected public and private Indian companies;

UNIT-III

CSR Planning and Institutionalising : InstitutionalizingCSR –various steps, corporate governance practices ,Indicators for measuring impacts, multi-stakeholder approach. Addressing Issues and challenges of CSR in India- sustainability, corporate disclosure, motivation for companies, investors' pressure, visibility factor, transparency, operating cost, duplication of work, alliance of industries for CSR, Corporate social reporting.

UNIT-IV

CSR based case discussion: Topic focus: concept, theory, approach, application and impact

- Green Business : Addressing Sustainable development
- Serving the world's poor profitably
- National Practice CSR case example
- Global best practice case example

Text Book:

1. Blowfield M, and Murray A 2008 Corporate Social Responsibility: A critical Introduction . Oxford University Press. USA

2. Bhattacharya, CB; Sen, Sankar; Korschun, Daniel (2011). Leveraging Corporate Social Responsibility: The Stakeholder Route to Business and Social Value. Cambridge: UK: Cambridge University Press.

Reference Books:

Visser, W.; Matten, D.; Pohl, M.; Tolhurst, Nick (2008). The A to Z of Corporate Social Responsibility.Wiley.ISBN 978-0-470-72395-1.

Kerr, M.; Janda, R.; Pitts, C. (2009). Pitts, C., ed. Corporate Social Responsibility: A Legal Analysis. Toronto: LexisNexis. ISBN 978-0-433-45115-0.Philip Kotlerand Nancy Lee(2005) Corporate Social Responsibility: Doing the Most Good for Your Company and Your Cause by Sage Publication. Sanjay K Agarwal (2008) Corporate Social Responsibility in India. Sage Publication.

Course Code: **EMOE 741** **L 4 P/T 0 Credits: 4**

Course Title: **Sustainable Ecotourism**

UNIT-I

Concept of Ecotourism: Definitions, ecotourism, difference between tourism, examples various forms, development of ecotourism in India and outside. Ecological, social and economic dimensions of ecotourism, eco-tourists, linkages with local culture, ethics and livelihoods, stakeholders' analysis, threats due to large scale ecotourism.

UNIT-II

The ecotourism perspectives: High value may also be high impact, bulk ecotourism and problems, stakeholder challenges. Ecotourism Policy and practices, national policy frame work, example – Madhya Pradesh &Uttarakhand State case.Successful ecotourism initiative, Criteria and Indicators for sustainable Ecotourism.Ecotourism certification,Accreditation of eco-lodges and resorts .

UNIT-III

Ecotourism alternative services and Ecotourism Products: sustainable extraction, extraction impacts, community involvement and compensation, shift from consumption to sustainable management. Concept of carrying capacity and factors. Designing ecotourism products and their relevance to ecology and livelihood, benefit sharing, capacity building of locals.

UNIT-IV

Case studies and analysis: Ecotourism in protected areas of India and abroad,

- Mangrove area and biodiversity conservation through ecotourism,
- Ecotourism in coastal areas
- Mountain area ecotourism in Sikkim
- Herbal ecotourism in Kerala,
- Wildlife area ecotourism.

Text Books:

1. Honey, Martha. 2008. Ecotourism and Sustainable Development: Who Owns Paradise? 2nd edition. Island Press.
2. Jennifer Louise Hill, Tim Gale 2005 Ecotourism and Environmental Sustainability: Principles and Practice. Ashgate Publishing Company. USA

Reference Books:

1. Patterson, Carol, Delia Owens, and Mark Owens. 2007. The Business of Ecotourism. Trafford Publishing.

2. Collier, Paul and Anthony J.J. Venables. 2011. Plundered Nations? Successes and Failures in Natural Resource Extraction. Palgrave MacMillan.
3. Seema Bhat & Syed Liyakhat 2008. Ecotourism Development in India: Communities, Capital and Conservation published by CEE, Ahmedabad.