

**DEPARTMENT  
OF  
ENVIRONMENTAL SCIENCE**  
*University of Kalyani*



***SYLLABUS***  
**FOR**  
**PROPOSED SEMESTER SYSTEM OF M. Sc. COURSE**  
**IN**  
**ENVIRONMENTAL SCIENCE**  
**FROM THE SESSION 2008 - 2009**

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**REGULATION OF M. SC. COURSE ON ENVIRONMENTAL SCIENCES  
UNIVERSITY OF KALYANI**

1. The Master degree on Environmental Science shall be open for the candidate who has passed the honours degree (with atleast 50% marks) in subjects of Biological sciences, Earth sciences, Physical sciences and allied field.
2. The candidate shall have to complete the course works, project works and also have to deliver a seminar talk preferably at the end of the academic year.
3. The selection of students for the said course will be made through admission test.
4. The course will be conducted by the Department of Environmental Science, Kalyani University in collaboration with other science Departments of the University, some experts from the other Institutions and Universities will be invited to deliver special lectures on the selected topics as included within the framework of the course.
5. The course of studies for Master of Environmental Sciences shall be divided into four semesters:  
The details of course structure is given in the separate format.
6. The examination rules and other details will be same as in case of the other subjects of the University.

**Proposed Syllabus for Master of Environmental Science  
(Semester System)**

**Course Structure**

<b>SEMESTER - I</b>
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**Theoretical**

Course 101 Environmental Biology	40
Course 102 Environmental Chemistry	40
Course 103 Environmental Geology	40
Course 104 Environmental Geography	40
Course 105 Ecology & Environmental Physiology	40
Course 106 Mathematical Methods	40

**Practical**

Course 107 Environmental Biology & Ecology	30
Course 108 Environmental Chemistry	30
Course 109 Environmental Geology	30
Course 110 Environmental Geography	30

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Total	360
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<b>SEMESTER - II</b>
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**Theoretical**

Course 201	Environmental Biotechnology	40
Course 202	Resource Management & Environmental Economics	40
Course 203	Environmental Health Science	40
Course 204	Environmental Pollution	40
Course 205	Environmental Physics	40
Course 206	Soil Science	40

**Practical**

Course 207	Environmental Biotechnology	30
Course 208	Pollution Monitoring	30
Course 209	Environmental Physics	30
Course 210	Environmental Physiology, Toxicology & Health Science	30

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Total	360
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<b>SEMESTER - III</b>
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**Theoretical**

Course 301	Environmental Impact Assessment Environmental Legislations, Movement,	40
Course 302	Land Degradation and Land Use Management	40
Course 303	Environmental Technology	40
Course 304	Application of Remote Sensing and GIS	40
Course 305	Environmental Statistics and Mathematical Ecology	40
Course 306	Human Ecology	40

**Practical**

Course 307	Remote Sensing and GIS Technique	30
Course 308	Environmental Statistics	30
Course 309	Socio economic and Epidemiological Survey	30
Course 310	Land Survey Technique and Map Preparation	30

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Total	360
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<b>SEMESTER - IV</b>
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**Theoretical****(Elective Papers - any four from courses 401 to 406)**

Course 401 Environmental Management	40
Course 402 Global Environmental issues	40
Course (403) Hydrogeology & Water Resource Management	40
Course (404) Landscape Ecology and Social Environment	40
Course (405) Radiation and Environment	40
Course (406) Wildlife Biology and Management	40

**Compulsory**

Course (407) Practical for Elective papers	40
Course (408) Dissertation** (preparation presentation)	80
Course (409) Grand-viva	40

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Total	320
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\* 20% marks in internal assessment evaluation.

Grand total (Semester I 360, Semester II 360, Semester III 360 and Semester IV 320)  
= 1400

## SEMESTER - I

### THEORETICAL

#### Course 101 ENVIRONMENTAL BIOLOGY

Total no. of lectures: 40

Full Marks - 40

##### A. Diversities of life forms:

a) **Plant diversity:** Plant nomenclature and ICBN; major classes of plants phyto-geographical regions of India; Rare and threatened plants; role of Botanical Survey of India in exploration of plant wealth. (4)

b) **Animal Diversity:** Major categories of animals, rare and threatened species of mammals, aves, reptiles and pisces and India with special reference to N.E. India; role of Zoological Survey of India/Zoo Authority of India in exploration and conservation of faunal wealth. (4)

c) **Microbial Diversity:** Fundamental concept of microbial diversity:- bacteria, fungi, actinomycetes; microbial diversity in man-made ecosystems and natural ecosystems; importance of microbes in nutrient cycling (3)

d) **Biodiversity:** Categories, basic measurement methods, computation of species richness indices – Margalef's index and Menhinick's index; Diversity indices – Shannon diversity index. Causes and consequences of loss of biodiversity; factor causing loss of biodiversity. Biodiversity Conservation: Need of biodiversity conservation; biodiversity conservation methods: In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots: Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank. Biodiversity Management: International/National policies and conservation strategies: Role of MAB, IUCN, Intellectual property rights – TRIPS, role of Indigenous Knowledge System (IKS), Biopiracy, rights of farmers, breeders and indigenous people. (10)

**B. Forest Ecology:** Definition of forest and forestry; Classification of forest and their distribution with special reference to mangrove forest. Composition of forest – fundamentals of forest population, community, succession, climax; components of a forest ecosystem. Interrelationship among different components in forest ecosystem endemic

Ecological values of forest, forest types of the world and India

Conservation of forest – definition, National and international conservation strategies. Indian Forest Conservation Act 1980, 1988). Importance of indigenous knowledge and peoples participation in forest conservation. Knowledge about – World Forestry day, World Environment Day, Vanamahotsav, Aranya Saptaha.

Forest Biotechnology – Forest resources & bioprocess

(10)

**C. Aquatic Ecology:**

(7)

Aquatic organism (flora, fauna and microbes), diversities of aquatic ecosystem food chain and function, Degradation of aquatic ecosystem eutrophication and their conservation, wetland – status and conservation priorities in India

**D. Biomonitoring of Environmental Quality :**

(2)

Aquatic biota and its utility in water quality monitoring; Soil biota and its utility in soil quality monitoring; Plant responses to air quality and its application in bio-monitoring of air

**References :**

1. Ecology with special reference to animals and man - S. C. Kandeigh.
2. Ecological methods for field and laboratory investigation - Michael.
3. Microbiology - Pelzer & Reid.
4. Environmental Science – S.C.Santra, 2006 New Central Book Agency Kolkata.
5. Forest Ecology (Vol. I&II) – G.S.Puri, P.Gupta, Oxford & 1 BH.
6. Forest Policy & Law – S.S.Negi, Indus Publishing Company

## Course 102 ENVIRONMENTAL CHEMISTRY

Total no. of lectures : 40

Full Marks - 40

(A) Chemical Thermodynamics

Laws of Thermodynamics; Reversible and irreversible processes; Carnot cycle; Thermodynamic functions (5)

(B) Chemical Kinetics

Order and molecularity of a reaction; Basic kinetic laws – first second, third order reactions; Determination of rate constant; The Arrhenius equation, Steady state concept, Enzyme Kinetics (7)

(C) Analytical Methods in Environmental Quality Assessment

Principles of titrimetry; Gravimetry; Colorimetry; Spectrophotometry; Spectrofluorimetry; Flame photometry, AAS; Chromatographic techniques; Gel electrophoresis and X-ray diffraction techniques (12)

(D) Photochemistry

Laws of photochemistry; Fluorescence and Phosphorescence phenomena; Chemical, photochemical and photosensitized reactions in the atmosphere Fluorescence Molecular Sensors (4)

(E) Bioinorganic chemistry

Classification of elements (specially heavy metals), coordination; organometallic and organometalloidal compounds, structure-toxicity relationships, chemical speciation, concept of chelates, chelation therapy and drug design.

Bioessential metals and their role in life processes, DNA – binding and biological activity of metal ligand complexes.

### References:

1. 'Physical chemistry' – P.W. Atkins – Oxford University Press
2. 'Principles and Practice of Analytical Chemistry' – F.W. Frifield and D. Keatey – Blackwell Science
3. Vogel's Text book of qualitative and quantitative analysis – ELBS
4. 'Handbook of analytical instruments' – Khandpur – Tata McGraw Hill
5. 'The Heavy Elements – Chemistry; Environmental impact and Health Effects' – Jack E. Fergusson, - Pergamon Press
6. 'Elements of Bioinorganic chemistry' – G.N. Mukherjee and A. Das
7. Environmental Chemistry (3<sup>rd</sup> Ed.) A.K. De, Wiley Education

## Course 103 ENVIRONMENTAL GEOLOGY

Total no. of lectures : 40

Full Marks - 40

- A. Geological time scale: An overview, palaeology (Quaternary and phanerozoic palaeontology). Reconstruction of palaeogeography – (4)
- B. Common rocks and minerals: Major categories and their mode of origin. Physical and chemical weathering of rocks – (5)
- C. Geomorphological process: Process and forms (Fluvial, eolian, glacial, coastal and Karst). Fundamentals of structural geology and tectonics - (5)
- D. Hydrological cycles and groundwater issues: (Aquifers, Aquitards, Darcy's law and hydraulic conductivity). Groundwater quality and contamination with reference to arsenic fluoride and nitrate– (5)
- E. Natural hazards and its management: Drought, Flood, Earth quake, and Landslide (10)
- F. Environmental issues of mineral exploration and exploitation: Coal and metal mining – (4)
- G. Geological considerations of engineering constructions: Dam, Road & Rail link, Landslide area – (4)
- H. Biogeochemical cycle: An overview, importance of chemical and biological processes in carbon, nitrogen and phosphorus cycle. – (3)

### Reference:

1. Environmental Geology by E.A.Keller - Charles E. Merrill Publishing Company
2. Environmental Geology by C.W.Montgomery – McGraw – Hill International
3. Principles of Geomorphology – W.D. Thornburry – Wiley Eastern

## **Course 104 ENVIRONMENTAL GEOGRAPHY**

**Total no. of lectures : 40**

**Full Marks - 40**

### **(A) Environmental Geography**

- i) Environmental geography – evolution and objectives – (3)
- ii) Man-environmental relationships – hunting gathering , fishing, mining, acquiring forestry– (3)
- iii) Environmental systems – System classification, open system, modification by human – (3)
- iv) Environmental degradation – Causes, resulting effects, remedies – (4)
- v) Land uses – Types of landuse, agriculture, urbanization, changes in landuse during historical times – (4)
- vi) Environmental management – Social responses, limitations – (3)

### **(B) Weather and Climate**

- i) Meteorology – Atmospheric composition circulation – (2)
- ii) Weather – Phenomena, synoptic descriptions (2)
- iii) Radiation – Electromagnetic radiation spectrum, Insulation (2)
- iv) Thermal environment – Radiation balance, heat transfer, seasons (3)
- v) Precipitation – Cloud formation, humidity, types, distribution – (4)
- vi) Climate – Types, continental and oceanic influence, importance in crop production – (4)
- vii) Indian Climate – Monsoon, rainfall pattern – (3)

### **Reference;**

1. An introduction to Physical Geography – A.N.Strahler, & Strahler, 1996, London, John Wiley & Sons.
2. Environmental Geography – S. Singh, 1991. Pragag Pustak Bhawan, Allahabad
3. Climatology – D.S.Lal
4. Physical Climatology – D.W.Sellers, 1965, Chicago, Checago University Press.
5. Atmosphere, Weather and Climate – R.G.Barry & R.J.Chorley, 1999, London, Routledge.

## Course 105 ECOLOGY AND ENVIRONMENTAL PHYSIOLOGY

Total no. of lectures : 40

Full Marks - 40

### A. Ecology :

- i) Evolution of Universe, evolution of elements, origin of life and evolution of life forms; (3)
- ii) Biological response to physical and chemical agents - acute and chronic effects (3)
- iii) History and scope of ecology, evolution of biosphere, (3)
- iv) Ecosystems of the world; (2)
- v) Succession process; community build up and stability; (2)
- vi) Population dynamics (4)
- vii) Ecosystems – concepts, Energy flow, productivity regulation & cybernetics (4)

### B. Environmental Physiology :

- i) Environmental physiology with considerations of Water metabolism, Buogancy and Osmotic balance; its Normonal regulation. (5)
- ii) Energy metabolism and body temperature changes; Thermo regulation and adaptation. (4)
- iii) Oxygen uptake from the Environment; respiration and metabolism. (2)
- iv) Neurophysiology and Information Processing. (2)
- v) Neuroendocrinology, and Hormone action.(2)
- vi) Immune cell responses, Immunity and Immunodeficiency, Neuroimmunomodulation.(2)
- vii) Biological clock (2)

### Reference:

1. Ecology – P. Collinvaux.
2. Fundamentals of Ecology – E. Odum.
3. Basic Ecology – E. Odum
4. Animal physiology, Adaptation and Environment – K. Schmidt.
5. Ecology: R.E.Ricklefs and G.C.Miller

**Course 106 MATHEMATICAL METHODS AND APPLICATION IN ENVIRONMENTAL SCIENCE**

**Total no. of lectures : 40**

**Full Marks - 40**

- A. Partial Differentiation with applications : Limit and Continuity, Partial derivative, Taylors Theorem, Maxima and Minima (7)
- B. Vector Calculus : concept of transformation, Divergence and Curl of a vector function Gauss's Theorem, Green's Theorem (7)
- C. Differential Equation : Linear equation, Bernoulli's equation. (6)
- D. Series Solution : Power series method and validity of series solution (6)
- E. Fourier Series and Integrals : Transformation, coefficients, even and odd functions. (7)
- F. Matrices : Linear operator, Matrix representation, Eigenvalues and eigenfunctions (7)

**References:**

1. Course on higher mathematics – Smirnov (Pergamon Press)
2. Linear Algebra – Lang (Addison Wesley)
3. Theory of functions - Titchmarsh (Oxford Univ. Press)
4. Mathematics for physics and chemistry – Margenau & Murphy (Van Nostrand)

## PRACTICAL

### Course 107 ENVIRONMENTAL BIOLOGY

**Total classes – 30**

**Full Marks: 30**

1. Plankton study – Qualitative & quantitative analysis- (5)
2. Microbiological analysis – Isolation and characterisation of bacteria, fungi, from soil & water. – (6)
3. Physiochemical analysis of soil- pH, conductivity, organic carbon, hardness (2)
4. Coliform detection of drinking water – (4)
5. Phytotoxicity assay – (4)
6. Primary productivity analysis – (2)
7. Phyto-sociological analysis of vegetation – (2)
8. Antifungal and antibacterial activity of toxic compounds. (2)
9. Field visit for ecosystem study (duration 5-7 days)

#### **References:**

1. Workbook on Limnology – Adoni A.D.
2. College Botany Practical (vol. I & II) S.C.Santra

### Course 108 ENVIRONMENTAL CHEMISTRY

**Total classes – 30**

**Full Marks: 30**

1. Chromatography: Paper, thin layer and gas liquid chromatography – and their application in separation of amino acids/sugars (4)
2. Flame photometer: Application of flame photometry in estimation of metals viz' K. and Na (4)
3. AAS: Determination of the concentration of As, Pb, Cr using AAS (3)
4. Spectrophotometry and Spectrofluorimetry:
  - i) Preparation of standard curve of  $\text{NO}_3^-$ ,  $\text{PO}_4^{3-}$  (7)
  - ii) Analysis of organic and inorganic substances.
5. Gel –Electrophoresis: Protein separation technique (4)

## **Course 109 ENVIRONMENTAL GEOLOGY**

**Total Lecture – 30**

**Full Marks: 30**

- i) Thematic map generation using SOI toposheet: Qualitative and quantitative analysis of land form and drainage basins and their environmental interpretation. (15)
- ii) Hand specimen study of common rocks and minerals: Microscopic study of common rocks. Model study of structural folds and faults. (15)

(Desirable: One field tour for appraisal of common landforms, rocks/mines/mining process; duration 2-4 days).

## **Course 110 ENVIRONMENTAL GEOGRAPHY**

**Total Lecture – 30**

**Full Marks: 30**

- a) Field survey techniques - (3)
- b) Toposheet interpretation - (12)
- c) Air photo study and interpretation – (6)
- d) Weather data interpretation - (9)

<b>SEMESTER - II</b>
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**THEORETICAL**

**Course 201 ENVIRONMENTAL BIOTECHNOLOGY**

**Total no. of lectures : 40**

**Full Marks - 40**

1. Understanding of Biotechnology – An overview – (1)
2. Environmental biotechnology, concept and broad outlines of various application areas – waste treatment, biodegradation of xenobiotic compounds, hydrocarbon degradation, biofuel production, biofertilizer, biopesticides production, and bioleaching. - (6)
3. Bioremediation: Concept, role of bioremediation in controlling various pollution problems – solid water, sewage water, industrial effluents, heavy metals, radioactive substances, oil spillage. - (4)
4. Phytoremediation: Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies. - (2)
5. Alternate fuels: source and mechanism of various biofuel production. - (2)
6. Integrated pest management: concept, technology involved in agriculture & forestry, Biopesticides application potential. - (2)
7. Biocomposting: – Microbial process involvement, vermin composting. - (2)
8. Biomining: Extraction of Cu, Au, etc from Ore by microbes - (4)
9. Waste Water treatment strategies: Domestic and Industrial wastewater, waste treatment microbiology - (3)
10. Biomethanation: Agro industrial wastes - (1)
11. Air borne microbes and allergic disorders - (2)
12. Basic techniques in Genetic Engineering: Recombinant DNA technology & its application in strain improvement. (5)
13. GM Crops and GMO: Environmental Implications – (4)

**Reference:**

1. Environmental Biotechnology – A.K. Chaterjee
2. Environmental Biotechnology (second edition) – Alan Scragg
3. Environmental Biotechnology – Bimal C. Bhattacharyya, Rintu Banerjee

## Course 202 RESOURCE MANAGEMENT & ENVIRONMENTAL ECONOMICS

**Total no. of lectures : 40**

**Full Marks - 40**

### **(A) Resources and conservation**

- i) Resources – Types, methods of exploitation, uses – (5)
- ii) Resource surveys – Different techniques – (3)
- iii) Management – Principles and Ways – (3)
- iv) Conservation – Planning, strategies National and regional – (5)
- v) Natural Resources – policies for sustainable development and conservation – (4)

### **(B) Environmental Economics**

- i) Environmental Economics – Basic principles, Economy and Environment – (4)
- ii) Environmental quality – Externality, types – (3)
- iii) Economic analysis – Cost effectiveness, cost-benefit, command and control system – (3)
- iv) Analytical tools – benefits and cost Isard model – (3)
- v) Environmental policy analysis – Criteria for policy analysis, policies in Industrialised countries – (4)
- vi) Economic valuation – Techniques for valuation, case studies – (2)

### **Reference:**

1. Readings in Resource Management and Conservation – I.Burton, and K.W.Kates, 1985, Chicago, University of Chicago Press
2. Ecodevelopment: Concepts, Projects, Strategies – B. Glaeser (ed) 1984, Oxford, Pergamon Press
3. Sustainable Development of the Biosphere – W.C.Clark and R.E.Munn (eds) 1986, Cambridge, Cambridge University Press
4. The Hand Book of Environmental Economics – W.Daniel, 1995, London, Black well
5. Environmental Economics – D.W. Pearce 1977, London, Longman Group Ltd.

## Course 203 ENVIRONMENTAL HEALTH SCIENCE

**Total no. of lectures : 40**

**Full Marks - 40**

- i) Environmental Toxicology, - an overview (2)
- ii) Ecological Toxicology and Forensic toxicology: Dose response relationships, frequency response and cumulative response; statistical concepts LD 50's – potency versus toxicity, (10)
- iii) Margin of safety-concepts of hypersensitivity and hyposensitivity- (4)
- iv) Biological factors that influence toxicity; chemical factors that influence toxicity, chemical factors that influence toxicity influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals (20)
- v) Carcinogens and Carcinogenesis (2)
- vi) Allergy and hypersensitive reactions (2)

### Reference:

1. Environmental Toxicology – Chandler
2. Environmental toxicology – Wright and Welbourn, Cambridge Univ. Press.
3. Basic toxicology – Frank C.Lu Mc Graw Hill International Book Company

## Course 204 ENVIRONMENTAL POLLUTION

Total no. of lectures : 40

Full Marks - 40

(A) Atmosphere and Atmospheric Chemistry - (20)

- Structure and composition of atmosphere, Reactions in the lower and upper atmosphere.
- Sources, types and fate of pollutants, persistent organic and inorganic air pollutants,
- Acid rain and photochemical smog
- Air quality standards
- Ambient air sampling, analysis and measurement,
- Mitigative measures, indoor air pollution,
- Vehicular pollution
- Air pollution management

(B) Water Pollution and Waste water transport - (20)

Sources and types of water pollutants; Ground water and surface water pollution; Sampling and analysis and measurement of water; Water quality standards; Effects on aquatic ecosystem; waste water composition and characteristics, waste water treatment, recycle/reuse, thermal pollution, Oil Pollution and Marine Pollution.

### Reference:

1. 'Environmental chemistry' – S.E.Manahan, - Villard Grant Press, USA
2. 'Environmental Engineering' – H.S.Peary, D.R.Rowe & G.Tchobanoglous, - McGraw Hill.
3. 'Environmental Chemistry' – G.W.Vanloon, S.J.Duffy, - Oxford University Press
4. 'Water Pollution – Causes, Effects, and Control' – P.K.Goel, New age International
5. 'Atmospheric Chemistry' – J.Heichlen, A.P.NY
6. 'Environmental Pollution' – H.M. Dix
7. 'Pollution Abatement' – K.M.Clayton
8. 'Environmental Engineering' A. Design Approach' – A.P.Sincero, G.A.Sincero' – Printice Hal India

## Course 205 ENVIRONMENTAL PHYSICS

Total no. of lectures : 40

Full Marks - 40

### A. The Atmosphere

Origin of earth and the solar system - nebula theory, Age of earth – radioactive dating, The evolution of the earth's atmosphere. Formation of ozone layer, Thermal structure of terrestrial systems - Runaway Green house effect – Thermal layers of atmosphere. Influence of solar radiations on earth atmosphere. Diffuse solar radiations - controlling factors, Distribution of sunshine hours, Effect of geomagnetic disturbances. (8)

### B. Atmospheric Motions

Atmospheric thermodynamics and radiation theory, Equation of motion for the atmosphere, Tropical motion systems. Global electric circuit. Solar modulation of atmospheric electrification. Global circulation model, Numerical weather forecasting, (8)

### C. Transport of Pollution

Atmospheric stability, Temperature inversion, Dispersion equation. Gaussian plume model – dry deposition of pollutant from stack. (8)

### D. Radioactivity

Characteristics of radioactive radiations, Measurement and application of radioisotopes, Units of radiation dose, Biological effects of nuclear radiation and safety measure. (8)

### E. Techniques in environmental physics

Common Weather and Doppler Radar, SODAR, LASER, LIDAR, Biosensor - principle and application, Bioacoustic - perception of loudness, combination of tones – Sound analysis, Noise pollution index, interference level and measurement of noise level. Ultrasound imaging and application (8)

### Reference:

1. Solar activity and Earth's climate – R.E. Benestad (Blindun, Norway)
2. Radiation Biophysics E.L. Aplen (Academic Press)
3. Biological thermodynamics D./T. Haynil (Cambridge Univ. Press)
4. Physics of the environment and Climate Gerard Guyo (John Wiley and Sons).
5. Atmospheric dynamics John Gaun (Cambridge Univ. Press)
6. Astronomy and Astrophysics A.B. Bhattachaya, S. Joardar and R. Bhattacharya.(Infinity Science Press, Massachusetts, USA)

**Course 206 SOIL SCIENCE**

**Total no. of lectures : 40**

**Full Marks - 40**

1. Definition and composition of soil- (2)
2. Formation of soil, origin, nature and classification of parent materials – (6)
3. Classification of soil – (4)
4. Factors affecting soil formation – (3)
5. Physical properties of parent materials, soil texture, Minerals of soil, soil colloids, soil air, water and soil organism, soil nutrients – (12)
6. Soil Contamination: Soil contamination due to application of pesticide and due to the presence of heavy metals, rupture of underground storage tanks. – (3)  
Health and ecosystem effect of contaminated soil
7. Soil erosion and soil conservation – (6)

**Reference:**

1. The Nature and Properties of Soils - Nyle C. Brady
2. Cycles of Soil – Stevenson, FJ. Wiley – Inter Science

## PRACTICAL

### **Course 207 ENVIRONMENTAL BIOTECHNOLOGY**

**Total classes – 30**

**Full Marks: 30**

1. Enzyme assay – amylase, catalase, peroxidase, ascorbic acid oxidase, cellulose - (7)
2. Estimation of metabolites, chlorophyll, phenolics, protein, carbohydrate, and fat – (7)
3. Assay of antimicrobial activity (2)
4. Assay of metal toxicity by plants (2)
5. Electrophoresis of protein (6)
6. DNA and RNA analysis & PCR techniques, handling and (6)
7. Determination bio accumulation of metal measurement by AAS (8)

### **Course 208 POLLUTION MONITORING**

**Total classes – 30**

**Full Marks: 30**

1. Physicochemical analysis of water and waste water – pH, Conductivity, BOD, COD, NO<sub>3</sub>, PO<sub>4</sub>, Hardness, Fe, As (10)
2. Use of various titrimetric and gravimetric methods in environmental analysis. Physicochemical analysis of soil – Texture, pH, Hardness Organic carbon – 4)
3. DNA interaction and cytotoxicity studies of metal complexes - (2)
4. Field trip for environmental quality monitoring/industry visit - (6)

#### **References:**

1. 'Standard Methods for the examination of water & waste water' – 21<sup>st</sup> edition, 2005, APHA, AWWA, WEF

## **Course 209 ENVIRONMENTAL PHYSICS**

**Total no of Lectures – 30**

**Full Marks: 30**

1. (T- $\Phi$ )gram and analysis of radiosonde data - (4)
2. Mapping and analysis of Surface charts - (4)
3. Identification of clouds and its topology - (4)
4. Coding and decoding of surface data - (4)
5. CWR and DWR products and interpretations. - (5)
6. Radiation study. - (4)
7. Field visit for study of microclimate, earth atmosphere interaction sound pollution index, process of solar terrestrial signal receiving earth platform. - (4)

## **Course 210 ENVIRONMENTAL HEALTH SCIENCE**

**Total no of Lectures – 30**

**Full Marks: 30**

1. Cell viability assay (MTT and Trypan blue) - (3)
2. Cell cycle analysis study by flow cytometry - (3)
3. DNA and Protein gel Electrophoresis - (3)
4. Immunohistochemistry and ELISA analysis - (3)
5. Sub cellular isolation and fractionation - (3)
6. Assay of Free radical release (Microscopical and Enzyme assay) - (3)
7. Fluorescence Microscopy and Confocal microscopy (Demonstration) – (3)
8. Southern and Western Blotting - (3)
9. Co-Immunoprecipitation and PCR analysis
10. Cell culture study for in vitro analysis - (3)

**SEMESTER - III**

**THEORETICAL**

**Course 301 ENVIRONMENTAL IMPACT ASSESSMENT, ENVIRONMENTAL LEGISLATIONS, MOVEMENT,**

**Total no. of lectures : 40**

**Full Marks - 40**

**1. Environmental Impact Assessment :**

Concept & scope of EIA, principle and salient features, EIA processes, methodologies, MOEF guidelines; Basic steps of overall appraisal of development projects - base line data collection & generation from the field; Identification & prediction of impacts of development project; Evaluation of impacts - different methods (checklist, adhoc, overlays, matrix, network and Bettle Environmental Evaluation Systems) - (8);

Preparation Environmental Management plan (EMP) for mitigation; Environmental impact statement; post project monitoring – (8)

Environmental. Audit System; some case studies of EIA/EMP and environmental auditing system. – (4)

**2. Environmental laws, treaty, regulation and movements :**

Environmental protection - issues and problems; statutory requirement for environmental clearance from state and central government of any developmental projects – (3);

Concept of environmental laws, pollution control acts, rules, notifications in India, UK, USA and other countries; Environmental policy resolution, Legislations, Public policy strategies in pollution control. Wildlife protection Act 1972, The water (Prevention and control of pollution) Act, 1974; Forest Conservation Act 1980, Air (Prevention and control of pollution) 1988; The Environmental (Protection) Act, 1986; Public Liability Insurance Act, 1991. Sanction and enforcement bodies of environmental laws - roles of Supreme Court and Green Bench of High Court on environmental protection in India – (10);

National Environmental policy; public awareness and participation in environmental protection movement in India – (2);

National environmental movements - Salient Valley movement, Chipko movement, Narmada movement, Appiko movement, Tehri & Garwal Dam movement, Uttar Kanda movement and Almatti dispute; Human resource manpower development and environmental education system in India and other countries. – (5)

**Reference:**

1. Environmental Impact Assessment – L.W.Canter
2. Environmental Science – S.C.Santra, New Central Book, Agency
3. Pollution Control Act, rules and Notifications – CBCB (2006)

## Course 302 LAND DEGRADATION AND LAND USE MANAGEMENT

Total no. of lectures : 40

Full Marks - 40

### (A) Land Degradation

- i) Land degradation – Genesis, types – (3)
- ii) Waste Land – Causes, distribution, environmental affects of waste lands - (4)
- iii) Desertification – Genesis, environmental effects desertification - (3)
- iv) Mapping – Methods of wasteland, desertification mapping use - (4)
- v) Management of wastelands – Problems and prospects - (3)
- vi) Carrying Capacity – Waste lands, Wetlands - (3)

### (B) Land use Management

- i) Landuse – Rural and Urban landuse - (3)
- ii) Policy – Landuse policy, problems and conflicts - (4)
- iii) Planning – Landuse planning and management of rural and urban landuse – (4)
- iv) Mapping of landuse – Application of remote sensing and other tools - (3)
- v) Changes – Changes in landuse over times - (3)
- vi) Restoration – Technological approach for restoration of landuse types - (3)

### Reference:

1. Land Degradation and Society – P.Blaikie and H.Brookfield, 1987, London, Methuen
2. The Cultural Landscape: Past Present and Future: H.H.Birks (eds)
3. Human Impact on the Earth – W.B.Mayer
4. Restoration Ecology and Sustainable Development - K.M.Urbanska (eds)
5. Natural Hazard in Human Ecological Perspective: Hypothesis and Models – R.W.Kates, 1970, Natural Hazards research working paper no. 14, Cambridge, USA
6. Landuse in Central Boston – W.Firey, 1947, Cambridge, Harvard University Press

## Course 303 ENVIRONMENTAL TECHNOLOGY

Total no. of lectures : 40

Full Marks - 40

### A. Environmental Technology for Pollution Control (20)

Concept of clean environment; Basis and necessity for standards; Non-point pollution sources; National and international aspects of pollution abatement;  
Air pollution abatement strategies – use of technological devices & green belt development;  
Water pollution abatement strategies; waste minimization approaches, cleaner production.  
Biotreatment technology

### B. Green Chemistry and Green Technology (20)

New trends in green chemistry, basics principles, Atom economy concept and its environmental importance, Green reagents, Green solvents and green catalysts – Properties, environmental significance and applications in day-to-day life.  
Microwave and ultrasound assisted reactions, concept of green technology, biocatalysis and bioprocessing,  
Uses of carbon dioxide, Industrial case studies – Greener synthesis of Ibuprofen,  
Polyester regeneration technology,  
Use of microbes as environmentally benign synthetic catalysts

### Reference:

- i) 'Pollution Control' – S.K.Shukla & P.R.Srivastava Commonwealth Publishers, New Delhi
- ii) 'Introduction to Environmental Engineering' – G.M.Marsters – Printice Hall India
- iii) 'Standard Methods for the examination of water & waste water' – 21<sup>st</sup> edition, 2005, APHA, AWWA, WEF
- iv) 'Green Chemistry' – Pault Anastas and Tracy C.Williamson – Oxford University Press
- v) 'Environmental Engineering – Water supply, Sanitary Engineering & Pollution' – A.Kamala, D.L. Kanth Rao Tata Mc Graw Hill.

## **Course 304 APPLICATION OF REMOTE SENSING AND GIS TECHNIQUE**

**Total no. of lectures : 40**

**Full Marks - 40**

- A. Principles of remote sensing: Electromagnetic radiations and their properties interaction of earth surface features with EMR. (8)
- B. Physical basis of remote sensing satellites and sensors and platform, data collection visible to near infrared, microwave remote sensing, hyperspectral remote sensing. (8)
- C. Thematic information extraction (6)
- D. Remote sensing application in GIS interface of GIS & RS. (6)
- E. Maps & spatial information, the components of geographical information system. (6)
- F. Data structure in GIS. Raster & vector data structures. (6)

### **Reference:**

1. Introductory Digital Image Processing – J.R.Jensen
2. Remote Sensing – Lillesand and Keifer

## **Course 305 ENVIRONMENTAL STATISTICS AND MATHEMATICAL ECOLOGY**

**Total no. of lectures : 40**

**Full Marks - 40**

### **A. Data collection and sampling**

Variables, Population and sample, Sampling methods, parameters and statistics, Sampling error. (5)

### **B. Presentation and location of data**

Frequency distribution, Pie gram, Bar diagram, Polygon, Histogram, Stem and leaf plot, Venn diagram, Measures of dispersion, Deviation, Variance. (5)

### **C. Probability Distribution**

Normal distribution, skewness, kurtosis, recognition of normal distribution, 't' distribution (5)

### **D. Testing of Hypothesis**

Null hypothesis, level of significance, alternative hypothesis, one tail and two tail tests (5)

### **E. Non parametric statistics**

Chi square test Wilcoxon signed rank test, U test (5)

### **F. Correlation and regression**

Product moment correlation, Spearman's rank correlation, simple regression analysis. (5)

### **G. Mathematical Ecology**

Classification of mathematical modelling, process of modelling, population growth model, population interaction, Lotka and Volterra prey predator system, energy flow in multi ecosystem. (10)

### **References:**

1. Introduction to statistics – C.Leach (J.Wiley New York, USA)
2. Mathematical Analysis for modelling J. Rosenblatt and S. Bell (CRC Press London, UK)
3. Statistics for Environmental biology and Toxicology W.E. Piegrosch and J.A.Bailer (Chapman and Hall London, UK)
4. General statistics W. Chase and F. Bown (J.Wiley Newyork., USA)

## Course 306 HUMAN ECOLOGY

**Total no. of lectures : 40**

**Full Marks - 40**

- A. Human Populations, Resources & Environment Dilemma - (3)
- B. Scope of Human Ecology, its importance in understanding conservation issues; People of India, diversity of culture and lifestyles; - (4)
- C. Different modes of resource use and differences with respect to technology economy, social organization, ideology, and nature of ecological impact; - (6)
- D. Human population growth/structure and its implications for the natural environment. (6)
- E. Ecology and Economy of Rural Communities: Rural ecosystem structure, organisation and function; Characteristics of rural subsistence economy, role of wildlands in subsistence economy, and the impact of market economy – (6)
- F. Social Development initiatives in India: Review of rural and tribal development programmes, and the impact of resource use practices and development programmes on local people and natural resources of the regions; Reasons for failure/success and lessons learnt; alternative approaches to development, integrated development, small is beautiful, eco-development. – (10)
- G. Epidemiological survey of Goiter, arsenicosis and fluorosis -(3)

### Reference:

1. Ecology and Mankind – C.L.Govind
2. Towards a Green World – A Agarwal and S. Narain, CSE, New Delhi

## PRACTICAL

### **Course 307 REMOTE SENSING & GIS TECHNIQUE**

**Total Lectures – 30**

**Full Marks: 30**

- i) Visual interpretation of standard FCC data   -(6)
- ii) Digital analysis of satellite data           - (6)
- iii) Thematic layer creation                       (8)
- iv) Digitization of thematic layers. Cross and overlay analysis. -(6)
- v) Digital elevation model (DEM) generation.       -(6)

### **Course 308 ENVIRONMENTAL STATISTICS**

**Total Lectures – 30**

**Full Marks: 30**

- 1. Graphical presentation of data               - (6)
- 2. Frequency distribution of data               - (6)
- 3. Statistical fluctuations of data               - (6)
- 4. Regression analysis of data                 - (6)
- 5. Use of statistical software                   - (6)

**Course 309 SOCIOECONOMIC AND EPIDEMIOLOGICAL SURVEY**

**Total Lectures – 30**

**Full Marks: 30**

- A. Socioeconomic survey in the near by village and urban areas(15)
- B. Epidemiological survey of chronic and disease-arsenicosis/Goiter/Flurosis/Malaria (15)

**Course 310 LAND SURVEY TECHNIQUE AND MAP PREPARATION**

**Total classes – 30**

**Full Marks: 30**

- a) Landuse mapping with ground truth data of nearby area (5)
- b) Updating of landuse map and the basis of field survey(10)
- c) Model development on landuse pattern – spatial entropy(15)

<b>SEMESTER - IV</b>
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**Course 401 ENVIRONMENTAL MANAGEMENT****Total no. of lectures : 40****Full Marks - 40**

- |   |     |
|---|-----|
| 1. International Efforts for Environmental Protection   | (2) |
| 2. National Efforts for Environmental protection – Policies and role of NGOs                  | (2) |
| 3. Global Environmental Problems and control strategies, Global environment monitoring system | (3) |
| 4. Urban Environmental Problem and managements  | (2) |
| 5. Industrial Ecology and management  | (2) |
| 6. Land Management Resource monitoring, conservation and management                           | (2) |
| 7. Water Management source assessment, wealth generation, & management                        | (2) |
| 8. Energy Management Source monitoring, conservation and management                           | (2) |
| 9. Waste Management Source monitoring, disposal, wealth generation and management             | (2) |
| 10. Environmental Management systems ISO14000 OHSAS: 18000, EMS implementation system         | (2) |
| 11. Trade, Business and Environment WTO, GATT, TRIPS, CBD issues                              | (1) |
| 12. Corporate Management system and Environmental Policies                                    | (1) |
| 13. Strategies for management of natural resources in India                                   |     |
| a) Water resource conservation and management   | (1) |
| b) Forest resource conservation and management  | (1) |
| c) Soil conservation and management   | (1) |
| d) Marine resource conservation and management  | (2) |
| e) Energy resource conservation and management  | (2) |

**References:**

1. Environmental Management – N.K. Oberoi
2. Green Business – Ed Sahay, Stough, Sonu, Goyal

## Course 402 GLOBAL ENVIRONMENTAL ISSUES

Total no. of lectures : 40

Full Marks – 40

- (A) Global climate change (10)  
Greenhouse gases and global warming, Ozone depletion and its impact on global climate, Temperature inversion, El-nino effect, Nuclear winter, Sea level rise and its consequences, Montreal Protocol, Kyoto protocol and recent conventions
- (B) Hazardous toxic waste (10)  
Concept, Sources, Properties, effect and fate of toxic wastes; Radioactive waste, Biomedical waste, e-waste; Hazardous waste treatment technologies, International treaties on disposal of hazardous waste, Hazardous waste management act, Industrial waste and waste water treatment – Steel, Pharmaceutical, Thermal, Cement textile etc.
- (C) Heavy metal pollution: (6)  
Definition, Properties and fate of heavy metals in environment. Biochemical effects of heavy metals (Pb, Hg, As, Cd, Cr, Se, Ck)
- (D) Energy and Environment (14)  
Concept of renewable, nonrenewable, conventional and nonconventional energy sources, solar energy, Bioenergy, geothermal energy, nuclear energy, wind energy, magnetohydrodynamic power.

### References:

1. 'Global warming' – M.Lal – Tata McGraw Hill.
2. 'Environmental Science' S.C.Santra – New Central Book Agency
3. 'Waste water Engineering – Treatment, disposal & reuse' – Metcalf & Eddy; Inc. – Mc. Graw Hill
4. 'Handbook of Industrial Pollution and control' – Vol. I&II, Bhatia – CBS
5. 'Prospect of Sustainable energy: A critical assessment' – E.S.Cassedy – Cambridge University Press.
6. 'The Green house effect, climatic change, and ecosystem' – B.Warrick, D.Jager – Wiley
7. 'Solid Waste Engineering' – Vesilind Worrell Reinhart – Thomson
8. 'The Heavy Elements – Chemistry, Environmental impact and Health Effects' – Jack E.Fergusson, Pergamon Press

**Course 403 HYDROGEOLOGY & WATER RESOURCE MANAGEMENT**

**Total no. of lectures: 40**

**Full Marks – 40**

1. Groundwater issues, Darcy's law, aquifers and hydrological cycle. - 4
2. Surface and sub-surface water relationship - 3
3. Groundwater exploration, conjunctive use of surface and ground water Water harvesting. Techniques. Different types of recharge structures in varying hydrological environment. Hydrogeomorphological mapping resistivity survey and water well drilling (13)
4. Water demand management (10)
5. Groundwater quality and contamination. Groundwater regions of India - 5
6. Managed aquifer recharge(MAR) - (9)

**References:**

1. Hydrogeology – Todd.
2. Water Resource Management – Herman Bouwer.
3. Water resources Engineering – R.A.Wurbs and W.P.James, PHI

## Course 404 LANDSCAPE ECOLOGY AND SOCIAL ENVIRONMENT

**Total no. of lectures : 40**

**Full Marks -40**

### **A. Landscape ecology (20)**

- i) Landscape ecology – Evolution, objectives of study basic tanets - (3)
- ii) Landscape structures – Patch, corridor and matrix - (3)
- iii) Landscape dynamics – Processes and changes - (3)
- iv) Landscape boundaries – Functional aspects, ecological flows - (2)
- v) Quantitative methods – Fractals, spatial intropy - (3)
- vi) Application of landscape ecological studies (including field study) – Planing process and management - (6)

### **B. Social environment (20)**

- i) Feed back mechanism – Population dynamics, demographic transition - (3)
- ii) Social organization – Society, Institutional aspects - (3)
- iii) Social system – Complex adaptive system - (3)
- iv) Environmental knowledge – Ecology and social construction - (3)
- v) Political ecology – Determinant narratives of political ecology - (3)
- vi) Environmental Identity – Traditional knowledge, application of knowledge - (5)

### **References:**

1. Landscape Ecology – R.T.T. Forman and M.Godron, Academic Press
2. Landscape Ecology – Navez and Libermman, Spinger verlap.
3. Changing Landscape: an Ecological Perspective – I.S.Zonnevetel and R.T.T.Forman (ed.), Springer verlap.

## Course 405 RADIATION AND ENVIRONMENT

**Total no. of lectures : 40**

**Full Marks - 40**

1. Sources – Natural – terrestrial, cosmic, atmospheric and radioisotopes present in living environment, Man made – radioactive fall out from nuclear explosion and nuclear power plant, radiology (10)
2. Nuclear radiation – successive disintegration , interaction with matter ,Nuclear reactor, Detectors and Accelerators, assessment of hazards, effects on health (10)
3. Cosmic radiation – origin, latitude and altitude effect, Hard and Soft component, Van Allen Radiation belt  
\*East west effect, cosmic ray showers, thermal history of universe, Hubble's Law and dark matters (10)
4. Atmospheric radiation - origin, victims to exposure, Atmospheric noise, variability of noise due to changing meteorological parameter. (10)

### References:

1. Bethe and Morrison: Elementary Nuclear Theory
2. Elton: Introductory Nuclear Theory: Wiley Interscience
3. Hughs: Elementary particles Cambridge Univ. Press
4. Bhattacharya; Astronomy and Astrophysics (Infinity Science Press, Massachusetts, USA)
5. E.L.Aplen: Radiation Biophysics Academic Press, London U.K.
6. Radiation detection and measurement G.F. Knoll John Wiley & Sons.

**Course 406 WILDLIFE BIOLOGY & MANAGEMENT**

**Total no of lectures 40**

**Full Marks 40**

**1. Wildlife biology:**

Concept of wildlife, importance of wildlife, endangered species, conservation (6)

Management of wildlife and their habitats (7)

Institutional support systems in understanding wildlife status of this country (6)

Basic principles of wildlife management; Role of Biology in management; the need for wildlife management; Lion, Rhino etc and habitat management techniques.(6)

**2. Wildlife farming:**

Objectives, management design, wildlife products: skins, meat, musk, etc food. Hygiene disease control, breeding.( 12)

Behavioral, ecology and evaluation: An interconnected approach (including proximate and ultimate mechanisms, and casual and functional explanations in behavioral) ecology (13)

**References:**

1. Wildlife Biology-C.H. Stevenson and Arwin
2. India's Wildlife and Wildlife resources – B.Seshadri sterling Publishing Pvt. Ltd.

**Compulsory**

**Course 407 Practical of Elective paper**

**Total no of lectures 30**

**Full Marks 40**

**Practical of Elective paper 401**

1. Biomonitoring of soil quality
2. Biomonitoring of water quality

**Practical of Elective paper 402**

1. Air quality monitoring- SPM, RPM, Sox, NOx

**Practical of Elective paper 403**

1. Hydrogeomorphological mapping
2. Hydraulic conductivity study

**Practical of Elective paper 404**

1. Landscape ecological analysis in field.
2. Fractal analysis of landform complexities.

**Practical of Elective paper 405**

1. Activity of radioactive sources, absorption of nuclear radiation
2. variability of incoming cosmic radiation, study of atmospheric noise

**Practical of Elective paper 406**

1. Field study of wildlife habitats and reporting.

**Course (408) – Dissertation\*\***

**Course (409) – Grand Viva**