Course No:	**BT-17206 -DCE**	**Maximum marks**	**75**
Course title:	**Laboratory Course II**		
Credits: Three			

1. Media Preparation
2. Isolation of Genomic DNA and RNA.
3. Agarose Gel electrophoresis and Quantification of DNA and RNA.
4. Immunoprecipitation (IP).
5. SDS-PAGE and Western Blotting.
6. Assay of Enzyme activity.
7. Effect of temperature and pH on enzyme activity.
8. Determination of Kinetic constants Km and V max.
9. Preparation of plant tissue culture media.
10. Plant Tissue Culture

Course No:	**BT-17306 -DCE**	**Maximum marks**	**75**
Course title:	**Laboratory Course III**		
Credits: Three			

1. Competent cell preparation
2. Bacterial Transformation
3. Plasmid Isolation
4. PCR gene amplification.
5. Restriction Digestion
6. Gene cloning
7. GST protein expression and purification
8. Animal Cell Culture.

CLB15103CR: Lab course-I

- Biochemical calculations
- Concept of pH and buffers
- Qualitative analysis of carbohydrates
- Qualitative analysis of amino acids
- Qualitative analysis of lipids
- TLC and paper chromatographyaminoacids and sugars
- Quantitative Estimation of proteins using Lowry's/ Biurett method
- Quantitative Estimation of glucose by Nelson Somogy's method
- Quantitative Estimation of cholesterol by Zlatki's Method
- Titrimetric estimation of ascorbic acid
- Sterilization techniques
- Preparation of culture media, pure culture techniques
- Study of bacterial growth by turbiditimetry/ spectrophotometry and serial dilution methods
- Extraction and Assay of Enzymes

CLB15203CR: Lab Course-II

- Isolation of bacterial genomic DNA
- Isolation of Plasmid DNA
- Preparation of genomic DNA from Plant tissue by CTAB method
- Isolation of DNA from blood samples by Phenol-Chloroform method
- Qualitative and quantitative determination of DNA
- Absorption spectra of Nucleic Acids and Determination of melting temperature of calf thymus DNA.
- Denaturation of DNA and UV absorption studies.
- Agarose gel electrophoresis
- Polyacrylamide gel electrophoresis (PAGE) and SDS- PAGE
- Amplification of DNA segment by PCR

CLB15303CR: Lab Course-III

- Estimation of serum albumin and determination of albumin/globulin ratio.
- Estimation of serum triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol.
- Estimation of serum bilirubin
- Estimation of serum acid phosphate, alkaline phosphate, ALT and AST and their clinical use
- Estimation of serum urea and creatinine
- Urine analysis – Routine and microscopic examination
- Sub Cellular fractionation and marker enzymes activity
- Estimation of serum of normal and sickle hemoglobin
- Estimation of T3, T4, and TSH by ELISA/RIA
- Estimation of antinuclear antibodies and C reactive protein
- Separation of mononuclear cells by Ficoll-Hypaque.
- TLC/ DLC
- Estimation of non-protein nitrogen, urea, urate, creatine and creatinine.
- Tests for urinary proteins
- Tests for lipids and lipoproteins
- Estimation of cholesterol
- Estimation of Na^{+}, K^{+} and Cl^{-}
- Estimation of Ca^{++}, Mg^{++} and P
- Estimation of Fe^{+2}, Cu^{+2} and Zn^{+2}
- Estimation of porphyrins and hemoglobin
- Tests for gastric function, occult blood
- Tests for liver and billiary tract diseases
- Tests for renal diseases

SEMESTER IV

CLB15401CR: Internship Dissertation

Internship represents a cross-over point between university and career. The experience one gets during an internship will indicate how he/she should structure future studies, particularly when it comes to deciding what aspects one should focus on. Students carry their internship program outside the parent department wherein project work will be carried out, based on research and actual bench work under the guidance of their respective supervisor at the place of internship. The department facilitates the students for placement for their internship. During the program the students are in close touch with their respective teachers in the department. The students are expected to put at least six working hours daily for a maximum period of six months. At the end of the internship, the internship dissertation will be submitted in the parent department and evaluated.

CLB15402CR: Host Institute Grading

During the internship, the students will be critically evaluated by the supervisors and will be graded by them based on their attendance in the lab, daily experimental work, writing and communication skills and other criteria related to routine lab work.

CLB15403CR: Internship Assessment

This will include an openers enation, defending their dissertation work to be evaluated by an external examiner (to be nominated by Head of the Department) and all the faculty members. The presentation will be followed by the viva of the students to be carried out by the external examiner.

ENG-13-0E: English Communication Skills-1

Unit I: Introduction to Communication:

- Types of Communication (Verbal and Non-Verbal)
- Barriers to Communication (Physical, Cultural and Psychological)
- Body Language (Eye Contact, facial expression, gestures and postures)

Unit II: English in Everyday Communication:

- Conversations
- Role play
- Simulation
- Presentation
- Group Discussion
- Interviews
- Discussions on Current topics

Paper ENS 102: Environmental Chemistry

Total Marks: Terminal Examination: 80 Internal Assessment: 20

Marks will be distributed equally among the four units. The question paper will be divided into three sections. Section A will contain eight very brief answer (10 – 20 words each) type questions (two from each unit), each carrying 2 marks. Section B will contain four medium answer (200 – 250 words) type questions (one from each unit), each carrying 8 marks. Section C will contain four long answer (400 – 500 words) type questions (one from each unit), each carrying 16 marks. While all the questions from Section A and B are to be attempted by a candidate, from Section C only two questions are to be attempted.

Unit I: Analytical & Environmental Chemistry (12 hrs. approx.)

1.1. Stoichiometry
1.2. Acid-base reactions
1.3. Titrimetry
1.4. Gravimetry
1.5. Solubility of gases in water

Unit II: Instrumentation techniques (12 hrs. approx.)

2.1. Principle and working of pH and conductivity meter
2.2. Spectrophotometry and flame photometry
2.3. Absorption and emission spectrophotometry
2.4. Chromatography - paper, TLC, GLC, HPLC
2.5. Radioactive tracers
2.6. NMR & ESR

Unit III: Chemistry of atmosphere and soil (12 hrs. approx.)

3.1. Thermo-chemical and photochemical reactions in the atmosphere and their effects
3.2. Chemistry of oxygen, ozone and other oxidants
3.3. Soil profile and Pedogenesis
3.4. Inorganic and organic components of soil
3.5. Physico- Chemical properties of soils

Unit IV: Water Characteristics (12 hrs. approx.)

4.1. Lake optics
4.2. Thermal phenomena in lakes and streams
4.3. Dissolved gases in water - CO_2, DO_2, H_2S and NH_3 and Biochemical oxygen demand and chemical oxygen demand
4.4. Carbonate system
4.5. Redox equilibria
4.6. Phosphorus and nitrogen in inland waters

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1. Environmental Chemistry: IAN Williams
2. Physical Chemistry: Puri, Sharma & Pathani
3. Environmental Chemistry: A. K. De
4. Environmental Chemistry: Stanley E. Manahan
5. An Introduction To Analytical Chemistry: S.A. Iqbal & M. Satake
6. Chromatography Of Environmental Hazards: Lawrence Fishbein
7. Principles Of Biochemistry: Wilson Walker
8. Electron Spin Resonance: J.E. Wertz And J.R. Bolton
9. Analytical Chemistry: D. Kealey And P.J. Haines
10. Text Book Of Quantitative Chemical Analysis: G.H. Jeffery, J. Basset, J. Mendham and R.C. Denney
11. The Surface Chemistry Of Soils: Garrison Sposito
12. The Nature & Properties Of Soils: Brady & Weil
13. Soils In Our Environment: Miller And Gardiner
14. Soil Genesis And Classification: Boul, Hole & Mccacken
15. Essentials Of Geology: Chernicoff, Fox, Venkatakrishnan
16. Text Book Of Limnology: Gerald A. Cole
17. Limnology: S.C. Agarwal
18. Limnology: R. G. Wetzel
19. A Treatise On Limnology: G. E. Hutchinson Vol I - III
20. Limnology. Goldman And Horne
21. Limnology. P. S. Welch
22. A text book of environmental chemistry: Tyagi and Mehra.
23. Soil in the environment: Daniel Hillel.
24. Weathering (An introduction to scientific principles): Bland and Rolls.
25. Soil fertility and fertilizers: Havlin et al.
26. Soil erosion and its control: R P C Morgan.
27. Soil properties: Liu and Evett.
28. Soil science and management: Edward J plaster.
29. Soils (An introduction): Singer and Munns.
30. Basic concept of environmental chemistry: Des W Connel.
31. Basic physical chemistry of the atmospheric science: Peter V Hobbs.
32. Environmental chemistry: Fritz Helmet.
33. Introductory chemistry for environmental science: Harrison and De Mora.
34. An introduction to environmental chemistry: Andrews et al.
35. Stream ecology: Barness and Mishall.
36. Aquatic Ecology: Mishra and saksena.
37. Advances in limnology: H R Singh.
38. High speed liquid chromatography: Rajcsanyi and Rajcsanyi.

43. Aquaculture technology and environment: Jadhoo.

Laboratory Course – ENS 111 (First Semester)

Marks: 200 (Internal Assessment 40 + Terminal Exam 160) Time 5hrs.

Course Contents

1. Estimation of volume of a water body – pond, pool, lake
2. Estimation of rate of flow of water.
3. Determination of water renewal time in a water body
4. Determination of the soil texture in different terrestrial habitats – agriculture land, wasteland, forest, desert and alpine pastures
5. Determination of temperature of soil, water and air samples.
6. Estimation of meteorological parameters.
7. Determination of latitude, longitude and altitude of a place
8. Study of major rock types.
9. Determination of light intensity in different habitats
10. Standardization of reagents – titrants (acids, bases).
11. Determination of pH, conductivity, alkalinity and acidity of water samples.
12. Estimation of pH, conductivity, alkalinity and acidity of sediment and soil samples.
13. Estimation of free carbon dioxide content in polluted and unpolluted waters.
14. Estimation of chloride content in different water bodies
15. Estimation of chloride content in different soil samples.
16. Estimation of cations (calcium, magnesium, sodium, potassium) water samples
17. Estimation of cations (calcium, magnesium, sodium, potassium) soil samples
18. Determination of Beer-Lambert's law.
19. Study of working of Spectrophotometer, Flame Photometer, Atomic Absorption Spectrophotometer and Ion Chromatograph.
20. Collection and Identification of herbs occurring naturally in University campus
21. Determination of primary productivity in terrestrial and aquatic habitats.
22. Productivity and biomass estimation of litter fauna.
23. Study of the pharmacognostic characters of important medicinal plants.
24. Collection and Identification of common aquatic macrophytes.
25. Collection and identification of the fish fauna of different aquatic habitats.

Paper ENS 202: Environmental Toxicology

Total Marks: Terminal Examination: 80 Internal Assessment: 20

Marks will be distributed equally among the four units. The question paper will be divided into three sections. Section A will contain eight very brief answer (10 – 20 words each) type questions (two from each unit), each carrying 2 marks. Section B will contain four medium answer (200 – 250 words) type questions (one from each unit), each carrying 8 marks. Section C will contain four long answer (400 – 500 words) type questions (one from each unit), each carrying 16 marks. While all the questions from Section A and B are to be attempted by a candidate, from Section C only two questions are to be attempted.

UNIT I: Principles of Toxicology (12 hrs. approx.)

1.1. Definition, scope, goals and divisions of toxicology
1.2. Dose - response relationship
1.3. Factors affecting environmental concentration of toxicants
1.4. Factors influencing toxicity
1.5. Toxicity of chemical mixtures
1.6. Statistical concept of toxicity

UNIT II: Xenobiotics & Toxicity Testing Methods (12 hrs. approx.)

2.1. Membrane permeability & mechanism of chemical transfer
2.2. Absorption & translocation of xenobiotics
2.3. Membranous barriers, binding of xenobiotics & storage depots
2.4. Excretion of xenobiotics
2.5. Toxicity testing methods (single & rnulti - species, acute, sub-acute and chronic toxicity tests)
2.6. Bioassay and its applications in toxicology

UNIT III: Toxicants as Public Health Hazard (12 hrs. approx.)

3.1. Pesticides
3.2. Automobile emissions
3.3. Heavy metals
3.4. Fertilizers
3.5. Food additives
3.6. Radioactive substances

UNIT IV: Bio-magnification of Xenobiotics (12 hrs. approx.)

4.1. Biomagnification of pesticides, heavy metals and radioactive substances
4.2. Biomagnification- study methods (microcosm)
4.3. Compartment models
4.4. Biotransformation: general principles and types of biotransformation
4.5. Antidotal procedures in toxicology
4.6. Chemical safety evaluation

BIBLIOGRAPHY

1. Physical Chemistry: Puri, Sharma & Pathani
2. Environmental Toxicology: M. Satake, Y. Mido, M.S. Sethi , S. A. Iqbal, H. Yasuhisa & S. Taguchi
3. Toxicology: P.D. Sharma
4. Introduction To Toxicology: J. Timbrell
5. Environmental Chemistry: Stanley E. Manahan
6. Modern Toxicology: Vol. I P.K. Gupta
7. Environmental Chemistry: S.C. Bhatia
8. Environmental Chemical Hazards: Ram Kumar
9. Pollution Management III Pesticide Pollution: S.K. Agarwal
10. Pollution Management IV Heavy Metal Pollution : S.K. Agarwal
11. Pesticides Man & Biosphere: O.P. Shukla, Omkar, A.K. Kulshretha
12. Pesticides & Environment: G.S. Dhaliwal, Balwinder Singh
13. Agricultural Pollution: Vol I S.G. Mishra, Dinesh Mani
14. Metallic Pollution: S.G. Mishra, Dinesh Mani
15. Chemicals In The Environment: Y. Mido & M. Satake
16. Fundamentals Of Environmental Chemistry: Stanley E. Manahan
17. Introductory Chemistry For Environmental Sciences: Harrison And Mora
18. Environmental Chemistry: B.K. Sharma
19. Environmental Chemistry: A. K. De
20. The Handbook Of Environmental Chemistry: O. Hutzinger Vol III Part A Anthropogenic Compounds
21. Environmental Toxicology: Ming- Ho- Yu
22. Toxicology: The Basic Science of Poison. Klaassen, C.D.
23. Principles and Methods of Toxicology. Hayes, A.W.
24. Statistics in Ecotoxicology. Sparks, T. (Editor).
25. Basic Toxicology: Fundamentals, Target organs, and Risk Assessment. Lu.
26. Toxicology of Insecticides. Matsumura, F.
27. Water contamination and health. Wang, R.G.M. (Editor).
28. Metal toxicity and tolerance in plants. Singh, V. P.

Credit IV: Environmental economics **(16 hrs)**

1.1. Environmental economics: Definition and scope
1.2. Population, poverty and environment
1.3. Concept of intangibles and externalities
1.4. Environmental evaluation methods: Hedonic pricing, contingent evaluation and household production function
1.5. Carbon credits and trading

ENS14108EO: Plant morphogenesis, Cyto-genotoxicity & Herbal Medicine (04 credits)

Credit I: Plant morphogenesis and regeneration **(16 hrs)**

1.1. Initiation, nutrition and maintenance of plant cell and tissue culture
1.2. Cellular totipotency, initiation of callus cultures and its characteristics
1.3. Cell differentiation and organogenesis
1.4. Suspension culture
1.5. Tissue culture studies of some threatened medicinal plants of Kashmir Himalaya

Credit II: Herbal medicine and health care **(16 hrs)**

1.1. Traditional Herbal Medicines for Healthcare and Management of Human diseases
1.2. Medicinal and aromatic materials from plants
1.3. Benefits of Medicinal and aromatic plant materials
1.4. Industrial utilization of medicinal plants
1.5. Phytochemical and anti microbial studies of some medicinal plants

Credit III: Cyto-genotoxicity **(16 hrs)**

1.1. Necrosis, apoptosis and inflammation
1.2. Somatic and genetic risk of environmental pollutants.
1.3. Cancer latency, threshold and non-threshold model of cancer
1.4. Mechanism of chemical carcinogens (free radicals and alkylating agents)
1.5. Classification of carcinogens (physical, chemical and biological agent)

Credit IV: Toxicogenomics (Testing protocols) **(16 hrs)**

1.1. Ames test and micronucleus test
1.2. Chromatid and chromosome aberration
1.3. Screening, tier testing and test batteries for mutagenicity testing
1.4. FISH technique
1.5. Use of Comet assay in environmental toxicology

Bibliography

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- Environmental Science. Cunningham, Saigo
- Environmental Science. Jackson & Jackson

- Environmental Science. Tyler Miller
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Physical Geology. Monroe & Wicander
- Concepts of Ecology. E.J. Kormondy
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Environment: Principles & Applications. Chris Park.
- Earth Systems. W.G. Ernst
- Environmental Science - Physical Principles & Applications. Boeker & Grondelle
- Fundamentals of Physical Environment. Briggs, Smithson, Addison & Atkinson
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Geosystems: An Introduction to Physical Geography. Robert W. Christopherson
- Introducing Physical Geography. Alan Starhler & Arthur Starhler
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Soils in our Environment. Miller and Gardiner
- Fundamentals of Soils. J. Gerrard
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- Principles of Environmental Science. Cummingham and Cunningham
- Environmental Sciences (System and Solutions). Mckinney and Schoch
- Principles of atmospheric physics and chemistry. Goody
- Smoke, Dust and Haze. S K Friedlander
- General Climatology. H. J. Critchfield
- Environmental Chemistry. IAN Williams
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- An Introduction to Analytical Chemistry. S.A. Iqbal & M. Satake
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- Ecology of a Changing Planet. Mark B. Bush
- Ecology for Environmental Sciences: Biosphere, Ecosystems & Man. J. M. Anderson
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- Instant Notes in Ecology. Mackenzie, Ball & Virder
- Primer of Ecological Theory. Jonathan Roughgarden
- Ecology with special reference to Animals and Man. S. Charles, Kendeigh
- Evolutionary Ecology. Eric R. Pianka
- A Primer of Ecology. Nichloas J. Gotelli
- Ecology Theories and Applications. Peter Stiling
- Applied Ecology and Natural Resource Management. Guy R. Mcpherson and Stephen Destefano
- Population Ecology. Begon & Mortimer
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- Wildlife Wilderness. G.A.Bhat
- Range ecology. Humphrey
- Flowers of the Himalaya. Adam Stainton
- Wildlife resources. Anderson.
- Microclimate - The Biological Environment, 2nd ed. Normal J. Rosenverg, Blaine L. Blad, Shashi B. Verma
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- The Global Casino. Nick Middleton
- Natural Hazard Mitigation. Godschalk, Beatley, Berke, Brower & Kaiser
- Active Tectonics. E. Keller & N.Pinter
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- Resources of the Earth. Craig, J.R., Vaughan, D.J. and Skinner, B.J.
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- Environmental Geochemistry. Eby, G.N.
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- Environmental Law, the Economy and Sustainable Development. Revesz, Sands and Stewart
- Higher Education in India. Mehraj-ud-Din
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- Issues in Environmental Economics. Hanley and Roberts
- Importance of Wildlife Conservation from Islamic Perspective. H.S.A. Yahya
- Psychology. Jhon J. Seamon, Douglas and T. Kenrick
- Society in Focus – Introduction to Sociology. William E. Thompson and Joseph V. Hickey
- Clinical Approach to Rural Development. E.D. Setty
- Environmental psychology. Annete Bolger
- Environment and Society. Francis Moore
- Environmental Economics-A Critical Overview. Alan Gilpin
- The economics of the environment and natural resources. R.Quentin Graflon et al.

General Instructions for the Candidates

1. The first semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

COURSE DESCRIPTIONS OPEN ELECTIVE

ENS17OE01: Environmental Ethics and Sociology (2 Credits)

Unit I

1.1. An introduction to environmental ethics and philosophy
1.2. Ethics in society
1.3. Responsibility for environmental degradation
1.4. Theories of environmental ethics and philosophy
1.5. Resource consumption patterns and the need for equitable utilization

Unit II

1.1. Role of agriculture in socio-economic development
1.2. Land reforms and Bhoodan movement in India
1.3. Community development projects
1.4. Rural social structure
1.5. Ecological theories of urbanization and urban social problem

ENS17OE02: Global Environmental Problems (02 Credits)

Unit I

1.1 Acid rain
1.2 Ozone depletion
1.3 Deforestation
1.4 Biodiversity loss
1.5 Global warming and climate change

Unit II

1.1.Role of an individual in conservation of natural resources
1.2.General idea about environmental laws
1.3.International conventions (Stockholm declaration)
1.4.Kyoto protocol and Montreal protocol
1.5.Earth summit

ENS17OE03: Environmental Protection (02 Credits)

Unit I

1.6. Role of an individual in conservation of natural resources
1.7. General idea about environmental laws
1.8. International conventions (Stockholm declaration)
1.9. Kyoto protocol and Montreal protocol
1.10. Earth summit

Unit II

1.1. Environment management
1.2. Control of soil, water and air pollution
1.3. Solid and hazards waste management
1.4. Biodiversity conservation
1.5. Natural resource management

ENS17OE04: Sustainable Development (2 credits)

Unit I

1.1. Concept and strategies of sustainable development
1.2. Principles of ecological economics – scope and usefulness
1.3. Prey-predator and supply-demand cycles

ENS14201CR: Environmental Pollution and its Control - I
(Air, Noise and Radioactive Pollution) **(04 credits)**

Credit I: Air pollution **(16 hrs)**

1.1. Sources, classification and properties of primary and secondary air pollutants
1.2. Pollutant behaviour in atmosphere
1.3. Smog and acid rain
1.4. Ozone layer depletion
1.5. Global warming and climate change

Credit II: Control of air pollution **(16 hrs)**

1.1. Indoor air pollution and its control: smoke, HCs, particulate matter, Radon
1.2. Air quality standards and Monitoring of air pollution: SOx, NOx, CO, SPM and hydrocarbon
1.3. Control of particulate, gaseous air pollution - SOx, NOx, CO and green house gases
1.4. Plume Rise and Design of Stack height
1.5. Bio-filters and control of air pollution

Credit III: Noise pollution and its control **(16 hrs)**

1.1. Noise pollution: Definition and sources
1.2. Measurement of Noise and sound pressure level,
1.3. Equivalent sound pressure level (Leq), Noise pollution level (NPL), Sound exposure level (SEL), Traffic noise index (TNI), Day-Night level (DNL), noise criteria curves
1.4. Impact of noise on human health and environment
1.5. Noise control and abatement measures

Credit IV: Thermal and radioactive pollution and its control **(16 hrs)**

1.1. Thermal pollution: causes and consequences
1.2. Control of thermal pollution
1.3. Radioactive pollution: causes and consequences
1.4. Types of radioactive pollutants and their sources
1.5. Radioactive waste management and control

ENS14202CR: Environmental Pollution and its Control - II
(Soil and Water Pollution) **(04 Credits)**

Credit I: Land degradation and soil pollution **(16 hrs)**

1.1. Causes and kinds of land degradation and Soil Pollution
1.2. Desertification: causes, consequences
1.3. Soil erosion: causes, assessment and environmental impacts
1.4. Fate of pesticides in soil
1.5. Industrial waste effluents and heavy metals and their interaction with soil components

Credit II: Control of land degradation and soil pollution **(16 hrs)**

1.1. Control of soil pollution
1.3. Soil conservation and control of soil erosion

ENS14201CR: Environmental Pollution and its Control - I
(Air, Noise and Radioactive Pollution) **(04 credits)**

Credit I: Air pollution **(16 hrs)**

1.1. Sources, classification and properties of primary and secondary air pollutants
1.2. Pollutant behaviour in atmosphere
1.3. Smog and acid rain
1.4. Ozone layer depletion
1.5. Global warming and climate change

Credit II: Control of air pollution **(16 hrs)**

1.1. Indoor air pollution and its control: smoke, HCs, particulate matter, Radon
1.2. Air quality standards and Monitoring of air pollution: SOx, NOx, CO, SPM and hydrocarbon
1.3. Control of particulate, gaseous air pollution - SOx, NOx, CO and green house gases
1.4. Plume Rise and Design of Stack height
1.5. Bio-filters and control of air pollution

Credit III: Noise pollution and its control **(16 hrs)**

1.1. Noise pollution: Definition and sources
1.2. Measurement of Noise and sound pressure level,
1.3. Equivalent sound pressure level (Leq), Noise pollution level (NPL), Sound exposure level (SEL), Traffic noise index (TNI), Day-Night level (DNL), noise criteria curves
1.4. Impact of noise on human health and environment
1.5. Noise control and abatement measures

Credit IV: Thermal and radioactive pollution and its control **(16 hrs)**

1.1. Thermal pollution: causes and consequences
1.2. Control of thermal pollution
1.3. Radioactive pollution: causes and consequences
1.4. Types of radioactive pollutants and their sources
1.5. Radioactive waste management and control

ENS14202CR: Environmental Pollution and its Control - II
(Soil and Water Pollution) **(04 Credits)**

Credit I: Land degradation and soil pollution **(16 hrs)**

1.1. Causes and kinds of land degradation and Soil Pollution
1.2. Desertification: causes, consequences
1.3. Soil erosion: causes, assessment and environmental impacts
1.4. Fate of pesticides in soil
1.5. Industrial waste effluents and heavy metals and their interaction with soil components

Credit II: Control of land degradation and soil pollution **(16 hrs)**

1.1. Control of soil pollution
1.3. Soil conservation and control of soil erosion

1.2. Waste lands and their reclamation
1.4. Sustainable agricultural practices
1.5. Integrated pest management

Credit III: Water pollution **(16 hrs)**
1.1. Sources and types of water pollution
1.2. Lake eutrophication and stream pollution
1.3. Petroleum hydrocarbons and marine pollution
1.4. Ground water pollution
1.5. Biocides and Heavy metals and their impact on aquatic life

Credit IV: Control of water pollution **(16 hrs)**
1.1. Water and waste water standards
1.2. Control of eutrophication and restoration of lakes
1.3. Wetland conservation
1.4. Role of aquatic plants in pollution abatement
1.5. Control of Stream pollution and Groundwater Management

ENS14203CR: Laboratory Course **(04 credits)**

Course Contents
1. Determination of silt load of a stream / river
2. Estimation of total dissolved and suspended solids in water
3. Determination of rate of soil erosion in different ecosystems
4. Estimation of dissolved oxygen, BOD, COD and dissolved organic matter in different waters
5. Estimation of organic carbon and organic matter in different soils samples
6. Estimation of nitrogen (NH_3, NO_2 and NO_3) and phosphorus (ortho- and total) in different waters
7. Estimation of phosphorus and nitrogen content in different soil samples
8. Estimation of dissolved silica and sulphate in different water bodies
9. Estimation of gaseous pollutants (SOx, NOx) and SPM in industrial emissions
10. Determination of SOx, NOx and SPM in ambient air
11. Qualitative and quantitative estimation of phytoplankton and periphyton community in different aquatic habitats
12. Qualitative and quantitative analysis of zooplankton in relation to eutrophication
13. Study of leaf pigment by paper chromatography and TLC methods
14. Comparative anatomical study of mesophytes, hydrophytes and xerophytes
15. Chemical characterization of ground water
16. Study of dose – effect relationships in important toxicants/pollutants
17. Estimation of protein and carbohydrate content in biological samples
18. Application of diversity indices in aquatic and terrestrial ecosystems
19. Spring and stream order classification
20. Biochemical tests for different enzymes

1.2. Waste lands and their reclamation
1.4. Sustainable agricultural practices
1.5. Integrated pest management

Credit III: Water pollution **(16 hrs)**
1.1. Sources and types of water pollution
1.2. Lake eutrophication and stream pollution
1.3. Petroleum hydrocarbons and marine pollution
1.4. Ground water pollution
1.5. Biocides and Heavy metals and their impact on aquatic life

Credit IV: Control of water pollution **(16 hrs)**
1.1. Water and waste water standards
1.2. Control of eutrophication and restoration of lakes
1.3. Wetland conservation
1.4. Role of aquatic plants in pollution abatement
1.5. Control of Stream pollution and Groundwater Management

ENS14203CR: Laboratory Course **(04 credits)**

Course Contents
1. Determination of silt load of a stream / river
2. Estimation of total dissolved and suspended solids in water
3. Determination of rate of soil erosion in different ecosystems
4. Estimation of dissolved oxygen, BOD, COD and dissolved organic matter in different waters
5. Estimation of organic carbon and organic matter in different soils samples
6. Estimation of nitrogen (NH_3, NO_2 and NO_3) and phosphorus (ortho- and total) in different waters
7. Estimation of phosphorus and nitrogen content in different soil samples
8. Estimation of dissolved silica and sulphate in different water bodies
9. Estimation of gaseous pollutants (SOx, NOx) and SPM in industrial emissions
10. Determination of SOx, NOx and SPM in ambient air
11. Qualitative and quantitative estimation of phytoplankton and periphyton community in different aquatic habitats
12. Qualitative and quantitative analysis of zooplankton in relation to eutrophication
13. Study of leaf pigment by paper chromatography and TLC methods
14. Comparative anatomical study of mesophytes, hydrophytes and xerophytes
15. Chemical characterization of ground water
16. Study of dose – effect relationships in important toxicants/pollutants
17. Estimation of protein and carbohydrate content in biological samples
18. Application of diversity indices in aquatic and terrestrial ecosystems
19. Spring and stream order classification
20. Biochemical tests for different enzymes

ENS14305EA: Environmental Statistics, Research Methodology & Information Technology **(04 credits)**

Credit I: Environmental statistics **(16 hrs)**

1.1. Basic elements and tools of statistical analysis:

a. Measurement of central tendency: Mean, mode and median.

b. Dispersion: Mean deviation, standard deviation, standard error and coefficient of variation

c. Probability, Normal, poisson and binomial distribution

1.2. Hypothesis testing: Sampling & test of significance: Student's t- distribution, F distribution, Chi Square distribution,

1.3. Simple and multiple correlation and regression coefficients

1.4. Analysis of variance

1.5. Post hoc tests in ANOVA: LSD, Tukey

Credit II: Research methodology **(16 hrs)**

1.1. Critical evaluation of area of research of the author

1.2. Literature review and data mining

1.3. Experimental design and methodology, methods of sampling

1.4. Data computation, preparation of scientific manuscript and dissertation / thesis

1.5. Research ethics, plagiarism, bio-safety and good laboratory practices

Credit III: Basics of computer **(16 hrs)**

1.1. Organization and working of a computer

1.2. Computer architecture fundamentals

1.3. Hard ware: types of memory - primary and secondary

1.4. Software: Windows operating systems; important features of MS word, MS excel, and MS power point

1.5. Use of computer in ecological predictions and models

Credit IV: Information technology and environment **(16 hrs)**

1.1. Information and communication technology: Advantages, disadvantages and uses

1.2. Information types, quality, needs and data processing - computer as a tool

1.3. Data mining and bioinformatics

1.4. Computer network and internet

1.5. Environmental communication: National and international scenario

ENS14306EA: Environmental Microbiology **(04 credits)**

Credit I: Microbial ecology **(16 hrs)**

1.1. History and scope of microbiology

1.2. General account of micro-organisms

a. Bacteria

b. Fungi, algae and viruses

c. Protozoa

1.3. Interactions between microbes and other organisms

1.4. Factors affecting growth of microorganisms
1.5. Brief introduction to thermophiles, barophiles, acidophiles, alkalophiles and psychrophiles

Credit II: Microbes and environment **(16 hrs)**

1.1. Nature and function of micro-organisms in Soil, Water and Air
1.2. Microbial spoilage of food and its preservation
1.3. Microbial activity in sewage disposal
1.4. Application of micro-organisms in the control of
   a. Oil pollution
   b. Chemical pollution - pesticides, synthetic polymers, and metals
   c. Bio-deterioration of materials
1.5. Role of microbes in fixation and solubilization / mineralization of nutrients: carbon, nitrogen, phosphorus, sulphur

Credit III: Microorganisms and human health **(16 hrs)**

1.1. Human health and environment: MMR, IMR, Life expectancy, incidence of chronic diseases
1.2. Epidemiology (Reservoir of infection, communicability and control)
   a. Air borne diseases: Tuberculosis, meningitis
   b. Soil borne diseases: Tetanus and gas-gangarine
   c. Water and food borne diseases: Cholera, typhoid, giardiasis, hepatitis
1.3. Allergic diseases
1.4. Insect vectors of human diseases like Malaria, Dengue, Encephalitis, and their control
1.5. Status of communicable diseases in India

Credit IV: Environmental and occupational health **(16 hrs)**

1.1. Basic principle of environmental health, Physiological responses of man to relevant stresses in the environment
1.2. Occupational Diseases: Principles and methods of occupational health
1.3. Industrial Toxicology: The relationship of occupation of hygiene and safety and disease
1.4. Evaluation and Control of occupational health hazards
1.5. Occupations health surveillance, occupational health control programmes in the context of Indian factories act-case studies

ENS14307EA: Remote Sensing and GIS **(04 credits)**

Credit I: Remote-sensing **(16 hrs)**

1.1. Definition, scope and its role in environmental science
1.2. Basic principles of remote sensing
   a. Electromagnetic radiation (EMR) and electromagnetic spectrum
   b. Interaction of EMR with atmosphere
   c. Spectral reflectance of vegetation, soil and water
1.3. Satellite systems: IRS, landsat and IKNOS
1.4. IR and microwave remote sensing
1.5. Aerial photography
   a. Definition and specifications for aerial photography

b. Types of aerial photography
c. Photogrammetry

Credit II: Image analysis and interpretation **(16 hrs)**

1.1. Fundamentals of image interpretation: Multi concept in image interpretation
1.2. Image analysis: Visual and digital, methods of image analysis
1.3. Image processing: Image characteristics and formats
1.4. Image rectification: Concept and techniques of digital image pre-processing
1.5. Image enhancement: Techniques of image enhancement

Credit III: Geographic information system **(16 hrs)**

1.1. Global positioning systems (GPS)
1.2. Principles and scope of GIS, use of GIS
1.3. Raster and vector GIS analysis
1.4. Map projections
1.5. Database concepts and types, data quality standards

Credit IV: Applications of remote sensing and GIS **(16 hrs)**

1.1. Environmental Impact assessment
1.2. Forest management
1.3. Watershed management and marine resources
1.4. Monitoring of biodiversity
1.5. Natural disaster management and regional planning

ENS14308EA: Ecological tour to Ladakh **(02 credits)**

During 3rd semester, students will be required to go for the field study tour within Jammu & Kashmir carrying 02 credits which will form a component of the elective allied. One credit will be given for participation and one credit for field collection, tour report and viva-voce.

ENS14309EO: Aquatic Environments & Environmental Biophysics **(04Credits)**

Credit I: Oceanography **(16 hrs)**

1.1. Formation and classification of water masses and mixing processes in the oceans
1.2. General aspects of ocean currents and circulation
1.3. Swell and currents induced by wind
1.4. Ocean thermal energy conversion (OTEC)
1.5. Vorticity

ENS14209EO: Analytical Instrumentation & Environmental Concerns (04 credits)

Credit I: Instrumentation-I (16 hrs)

1.1. Principle and applications of microscopy
1.2. Fluorescent, confocal and electron microscopy
1.3. Principle of centrifugation and its applications
1.4. Ultracentrifugation and its applications
1.5. Chromotography-gel chromatography, GLC, HPLC

Credit II: Instrumentation-II (16 hrs)

1.1. Visible and UV spectroscopy
1.2. Spectro-flourimetry
1.3. Electrophoresis-PAGE, SDS-PAGE
1.4. PCR & agarose gel electrophoresis
1.5. BLOT techniques

Credit III: Environmental security (16 hrs)

1.1. Overview of Environmental security and conflict
1.2. Neo-malthusians and political ecologists
1.3. Oil and water conflict
1.4. Armed conflict and environment
1.5. Climate change and conflict

Credit IV: Electromagnetic pollution (16 hrs)

1.1. Cell phone problem
1.2. Cell phone use patterns
1.3. Radiofrequency (RF) exposure from cell phones, headsets, mobile towers etc
1.4. Radio frequency exposure of various age groups
1.5. Health risks of Electromagnetic pollution

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- Basic Toxicology: Fundamentals, Target organs, and Risk Assessment. Lu
- Toxicology of Insecticides. Matsumura, F.
- Water contamination and health. Wang, R.G.M. (Editor).

General Instructions for the Candidates

1. The second semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 8 credits (2 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (Open) from outside the parent Department/ offered by any other Department/Faculty.
5. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

ENS14301CR: Environmental Impact Assessment & Ecological Modeling (04 credits)

Credit I: Fundamentals of EIA (16 hrs)

1.1. Environment impact assessment: Concept, objectives and approaches
1.2. Baseline data generation and Strategic environmental assessment
1.3. EIA guidelines 2006 and amendments
1.4. Protocol for environment impact statements
1.5. Public participation in environmental decision making

Credit II: EIA methodologies (16 hrs)

1.1. EIA methodology
1.2. Air and water quality assessment
1.3. Ecological assessment
1.4. Social impact assessment
1.5. EIA case studies:
Hydel, industrial estates, highways, thermal and nuclear power projects, cement and chemical industries

Credit III: Environmental auditing and planning (16 hrs)

1.1. Principles and guidelines of environmental auditing; ISO 14000 series
1.2. Preparation and submission of audit report
1.3. Environmental planning: Importance and objectives
1.4. Land use planning
1.5. Urban and rural development and environmental planning

Credit IV: Ecological modeling (16 hrs)

1.1. Role of models in ecology
1.2. Components of a model
1.3. Classes of mathematical models
1.4. Models of population (growth and interaction) and pollutant dispersal
a. Lotka – Volterra model
b. Leslie's matrix model
c. Gaussian plume model
1.5. Modelling of air quality, water quality and noise characteristics

ENS14302CR: Environmental Engineering (04 credits)

Credit I: Basics of environmental engineering (16 hrs)

1.1. Environmental Engineering: Introduction and scope
1.2. Sewage and Storm water drainage
1.3. Planning of housing drainage and rural sanitation
1.4. Environmental sanitation: Ventilation and air conditioning
1.5. Ecological sanitation

Credit II: Drinking water treatment **(16 hrs)**

1.1. Methods of water purification: Flocculation, sedimentation, sedimentation with coagulation
1.2. Filtration: Sand filters, pressure filters, horizontal filters
1.3. Disinfection and desalination of water
1.4. Chemical treatment: Adsorption, gas stripping, ion exchange
1.5. Reverse osmosis and distillation

Credit III: Sewage treatment **(16 hrs)**

1.1. Wastewater Treatment Plants: Concept, methods and design
   a. Primary
   b. Secondary
   c. Tertiary
1.2. Sludge and its disposal techniques
1.3. Natural methods of sewage disposal
1.4. Biology of sewage treatment
1.5. Reclamation and reuse of industrial and domestic wastewater

Credit IV: Solid and hazardous waste management **(16 hrs)**

1.1. Sources and generation of solid wastes and their characteristics
1.2. Methods of disposal of solid wastes.
1.3. Hospital waste management
1.4. Hazardous waste: Source, transportation, treatment, storage and disposal
1.5. Management of solid, industrial and hazardous wastes and Site remediation

ENS14303CR: Laboratory Course **(04 credits)**

Course Contents

1. Preparation of bacterial smears and gram staining
2. Estimation of bacterial population in different water samples by culture technique
3. Estimation of fungal population in different habitats through culture techniques
4. Case studies based on environmental laws
5. Survey of different residential areas for determining the prevalence of different air, water, soil and food borne diseases
6. EIA – Leopold Matrix method and Case studies
7. Socio-economic studies – preparing of questionnaire and Case studies
8. Computation of standard deviation, standard error and coefficient of variation
9. Computation of Correlation and Regression
10. One way and two way classification of ANOVA
11. Computation of Post hoc tests using statistical software
12. Preparation of different pollution themes with the help of MS PowerPoint
13. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
14. Land use / land cover classification from satellite data
15. Delineation of drainage of a given area from satellite data
16. Delineation of point, line and polygon themes
17. Preparation of thematic maps using R. S. maps.

18. Working and design of treatment plants
19. Study of effect of wastewater - treatment on seed germination
20. Study of morphogenetic response of explants on media

ENS14304EA: Environmental Laws **(04 credits)**

Credit I: Environmental Protection **(16 hrs)**

1.1. Environment protection: Issues and problems
1.2. National efforts on environmental protection, laws and policy in India
1.3. International efforts for environment protection (Stockholm, montreal, kyoto protocol & earth summit)
1.4. CITES (1973), Biodiversity act (2002) and Espoo convention (1991)
1.5. Indus Water Treaty (1960)

Credit II: National Laws-I **(16 hrs)**

1.1. Provisions of constitution (article 21,48A, 51A, and 253)
1.2. Indian forest act (1927), forest conservation act (1980) and rules (1981)
1.3. Wildlife protection act (1972) and amended (2002) and J & K wildlife (protection) act (1978) as amended in (2002)
1.4. The Water (Prevention and Control of Pollution) act (1974) as amended up to (1988) and rules (1975)
1.5. The air (prevention and control of pollution) act as amended by amendment act (1987) and rules (1982)
1.6. The environmental (protection) act (1986) and rules (1986)

Credit III: National Laws-II **(16 hrs)**

1.1. Hazardous waste management and handling rules (1989)
1.2. Biomedical waste (management and handling) rules (1998)
1.3. Noise pollution (regulations and control) rules (2000)
1.4. Municipal solid wastes (management and handling) rules (2000)
1.5. Environmental related laws in J&K (brief description)

Credit IV: National Policy **(16 hrs)**

1.1. National forest policy (1988)
1.2. Public liability insurance act (1991)
1.3. Intellectual property rights and patent act (2005)
1.4. National environment tribunal act (1995)
1.5. National green tribunal act (2010)

1.3. Landscape: Structure and processes
1.4. Tools and approaches in landscape ecology
1.5. Design of conservation reserves

ENS14404EA: Project Work **(08 credits)**

It is a special paper where a candidate carries out the application of knowledge in solving/ studying/ exploring a real life/ difficult problem in a creative way. The project work shall be of 8 credits. The project work shall be discipline centric and the candidate has to study the project work on his own with an advisory support by the concerned teacher.

The distribution should be as follows:

- **Part I:** Identification of problem area and literature survey
- **Part II:** Study of specific literature in detail pertaining to the statement of the problem
- **Part III:** Developing a solution, methodology or proposing a hypothesis to solve the problem
- **Part IV:** Experimental analysis, results, discussion, conclusion and recommendations

ENS14405EA: Environmental Biotechnology **(04 credits)**

Credit I: Introduction to environmental biotechnology **(16 hrs)**
1.1. Biotechnology
  a. Concept and environmental relevance
  b. Environmental risks
1.2. Biotechnology in Pollution control
1.3. Genetically modified organisms and bio-safety: A general account.
1.4. Environmental genomics: A key to understanding biology, pathophysiology and disease
1.5. Molecular taxonomy: Documenting biodiversity by DNA barcoding

Credit II: Eco-friendly role of animals **(16 hrs)**
1.1. Vermiculture technology
  a. Earth worms and soil productivity
  b. Earthworm culture and vermi-composting
1.2. Aquaculture improvement through biotechnology
1.3. Fish farming through biological wastes
1.4. Stem cell and animal cloning
1.5. Biological control of insects -definition, principles and control mechanisms

Credit III: In-vitro storage of plants **(16 hrs)**
1.1. Tissue culture: Concept, importance and methodology
1.2. Micropropagation techniques and application
1.3. Conservation: Short term, medium term and long term
1.4. Recent developments in cryopreservation

1.5. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA Banks

Credit IV: Crop improvement through plant tissue culture **(16 hrs)**

1.1. Embryo culture
1.2. Anther and Pollen Culture
1.3. Protoplast culture
1.4. Somaclonal variation, their merits and demerits
1.5. Synthetic seeds

ENS14406EA: Wildlife Management **(04 credits)**

Credit I: Extinction and conservation **(16 hrs)**

1.1. Extinction: Introduction, types and causes
1.2. Factors affecting risk of extinction
1.3. Population viability analysis as part of recovery plans
   a. Minimum viable population sizes
   b. Ecological islands
1.4. Captive breeding in animals
1.5. Reintroduction of species

Credit II: Threatened species **(16 hrs)**

1.1. Nature of the criteria used to determine the threatened status
1.2. Cetartiodactyla (Cervidae and Moschidae)
   a. Kashmir red deer (*Cervus hanglu*) †
   b. Kashmir musk deer (*Moschus cupreus*) †
1.3 Cetartiodactyla (Bovidae)
   a. Markhor (*Capra falconeri*) †
   b. Chiru (*Pantholops hodgsonii*) †
1.4. Carnivora
   a. Snow leopard (*Panthera uncial*) †
   b. Himalayan brown bear (*Ursus arctos*) †
1.5. Passeriformes & Gruiformes
   a. Kashmir flycatcher (*Ficedula subrubra*) †
   b. Black-necked crane (*Grus nigricollis*) †

† *(Brief background on assessment information, geographic range, population, habitat & ecology, threats and conservation actions)*

Credit III: Important bird Areas **(16 hrs)**

1.1. Vegetation characteristics within various biogeographic zones of India
1.2. Important bird Areas: Concept, aims, global viewpoint
1.3. Objectives and methods of the Indian IBA programme
1.4. Globally threatened species of the Indian Trans-Himalayas
1.5. Important Bird Areas in Jammu & Kashmir: General overview

Credit IV: Monitoring and evaluation **(16 hrs)**

1.1. Sampling designs for population estimation

1.4. Factors affecting growth of microorganisms
1.5. Brief introduction to thermophiles, barophiles, acidophiles, alkalophiles and psychrophiles

Credit II: Microbes and environment **(16 hrs)**

1.1. Nature and function of micro-organisms in Soil, Water and Air
1.2. Microbial spoilage of food and its preservation
1.3. Microbial activity in sewage disposal
1.4. Application of micro-organisms in the control of
   a. Oil pollution
   b. Chemical pollution - pesticides, synthetic polymers, and metals
   c. Bio-deterioration of materials
1.5. Role of microbes in fixation and solubilization / mineralization of nutrients: carbon, nitrogen, phosphorus, sulphur

Credit III: Microorganisms and human health **(16 hrs)**

1.1. Human health and environment: MMR, IMR, Life expectancy, incidence of chronic diseases
1.2. Epidemiology (Reservoir of infection, communicability and control)
   a. Air borne diseases: Tuberculosis, meningitis
   b. Soil borne diseases: Tetanus and gas-gangarine
   c. Water and food borne diseases: Cholera, typhoid, giardiasis, hepatitis
1.3. Allergic diseases
1.4. Insect vectors of human diseases like Malaria, Dengue, Encephalitis, and their control
1.5. Status of communicable diseases in India

Credit IV: Environmental and occupational health **(16 hrs)**

1.1. Basic principle of environmental health, Physiological responses of man to relevant stresses in the environment
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1.4. Evaluation and Control of occupational health hazards
1.5. Occupations health surveillance, occupational health control programmes in the context of Indian factories act-case studies

ENS14307EA: Remote Sensing and GIS **(04 credits)**

Credit I: Remote-sensing **(16 hrs)**

1.1. Definition, scope and its role in environmental science
1.2. Basic principles of remote sensing
   a. Electromagnetic radiation (EMR) and electromagnetic spectrum
   b. Interaction of EMR with atmosphere
   c. Spectral reflectance of vegetation, soil and water
1.3. Satellite systems: IRS, landsat and IKNOS
1.4. IR and microwave remote sensing
1.5. Aerial photography
   a. Definition and specifications for aerial photography

b. Types of aerial photography
c. Photogrammetry

Credit II: Image analysis and interpretation **(16 hrs)**

1.1. Fundamentals of image interpretation: Multi concept in image interpretation
1.2. Image analysis: Visual and digital, methods of image analysis
1.3. Image processing: Image characteristics and formats
1.4. Image rectification: Concept and techniques of digital image pre-processing
1.5. Image enhancement: Techniques of image enhancement

Credit III: Geographic information system **(16 hrs)**

1.1. Global positioning systems (GPS)
1.2. Principles and scope of GIS, use of GIS
1.3. Raster and vector GIS analysis
1.4. Map projections
1.5. Database concepts and types, data quality standards

Credit IV: Applications of remote sensing and GIS **(16 hrs)**

1.1. Environmental Impact assessment
1.2. Forest management
1.3. Watershed management and marine resources
1.4. Monitoring of biodiversity
1.5. Natural disaster management and regional planning

ENS14308EA: Ecological tour to Ladakh **(02 credits)**

During 3rd semester, students will be required to go for the field study tour within Jammu & Kashmir carrying 02 credits which will form a component of the elective allied. One credit will be given for participation and one credit for field collection, tour report and viva-voce.

ENS14309EO: Aquatic Environments & Environmental Biophysics **(04Credits)**

Credit I: Oceanography **(16 hrs)**

1.1. Formation and classification of water masses and mixing processes in the oceans
1.2. General aspects of ocean currents and circulation
1.3. Swell and currents induced by wind
1.4. Ocean thermal energy conversion (OTEC)
1.5. Vorticity

b. Types of aerial photography
c. Photogrammetry

Credit II: Image analysis and interpretation **(16 hrs)**

1.1. Fundamentals of image interpretation: Multi concept in image interpretation
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ENS14308EA: Ecological tour to Ladakh **(02 credits)**

During 3rd semester, students will be required to go for the field study tour within Jammu & Kashmir carrying 02 credits which will form a component of the elective allied. One credit will be given for participation and one credit for field collection, tour report and viva-voce.

ENS14309EO: Aquatic Environments & Environmental Biophysics **(04Credits)**

Credit I: Oceanography **(16 hrs)**

1.1. Formation and classification of water masses and mixing processes in the oceans
1.2. General aspects of ocean currents and circulation
1.3. Swell and currents induced by wind
1.4. Ocean thermal energy conversion (OTEC)
1.5. Vorticity

ENS14301CR: Environmental Impact Assessment & Ecological Modeling (04 credits)

Credit I: Fundamentals of EIA (16 hrs)

1.1. Environment impact assessment: Concept, objectives and approaches
1.2. Baseline data generation and Strategic environmental assessment
1.3. EIA guidelines 2006 and amendments
1.4. Protocol for environment impact statements
1.5. Public participation in environmental decision making

Credit II: EIA methodologies (16 hrs)

1.1. EIA methodology
1.2. Air and water quality assessment
1.3. Ecological assessment
1.4. Social impact assessment
1.5. EIA case studies:
Hydel, industrial estates, highways, thermal and nuclear power projects, cement and chemical industries

Credit III: Environmental auditing and planning (16 hrs)

1.1. Principles and guidelines of environmental auditing; ISO 14000 series
1.2. Preparation and submission of audit report
1.3. Environmental planning: Importance and objectives
1.4. Land use planning
1.5. Urban and rural development and environmental planning

Credit IV: Ecological modeling (16 hrs)

1.1. Role of models in ecology
1.2. Components of a model
1.3. Classes of mathematical models
1.4. Models of population (growth and interaction) and pollutant dispersal
a. Lotka – Volterra model
b. Leslie's matrix model
c. Gaussian plume model
1.5. Modelling of air quality, water quality and noise characteristics

ENS14302CR: Environmental Engineering (04 credits)

Credit I: Basics of environmental engineering (16 hrs)

1.1. Environmental Engineering: Introduction and scope
1.2. Sewage and Storm water drainage
1.3. Planning of housing drainage and rural sanitation
1.4. Environmental sanitation: Ventilation and air conditioning
1.5. Ecological sanitation

Credit II: Drinking water treatment **(16 hrs)**

1.1. Methods of water purification: Flocculation, sedimentation, sedimentation with coagulation
1.2. Filtration: Sand filters, pressure filters, horizontal filters
1.3. Disinfection and desalination of water
1.4. Chemical treatment: Adsorption, gas stripping, ion exchange
1.5. Reverse osmosis and distillation

Credit III: Sewage treatment **(16 hrs)**

1.1. Wastewater Treatment Plants: Concept, methods and design
   a. Primary
   b. Secondary
   c. Tertiary
1.2. Sludge and its disposal techniques
1.3. Natural methods of sewage disposal
1.4. Biology of sewage treatment
1.5. Reclamation and reuse of industrial and domestic wastewater

Credit IV: Solid and hazardous waste management **(16 hrs)**

1.1. Sources and generation of solid wastes and their characteristics
1.2. Methods of disposal of solid wastes.
1.3. Hospital waste management
1.4. Hazardous waste: Source, transportation, treatment, storage and disposal
1.5. Management of solid, industrial and hazardous wastes and Site remediation

ENS14303CR: Laboratory Course **(04 credits)**

Course Contents

1. Preparation of bacterial smears and gram staining
2. Estimation of bacterial population in different water samples by culture technique
3. Estimation of fungal population in different habitats through culture techniques
4. Case studies based on environmental laws
5. Survey of different residential areas for determining the prevalence of different air, water, soil and food borne diseases
6. EIA – Leopold Matrix method and Case studies
7. Socio-economic studies – preparing of questionnaire and Case studies
8. Computation of standard deviation, standard error and coefficient of variation
9. Computation of Correlation and Regression
10. One way and two way classification of ANOVA
11. Computation of Post hoc tests using statistical software
12. Preparation of different pollution themes with the help of MS PowerPoint
13. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
14. Land use / land cover classification from satellite data
15. Delineation of drainage of a given area from satellite data
16. Delineation of point, line and polygon themes
17. Preparation of thematic maps using R. S. maps.

Course Descriptions 4th SEMESTER

CORE COURSES

ENS17401CR: Environmental Engineering (04 credits)

Unit I: Fundamentals of environmental engineering

1.1. Environmental engineering: Introduction and scope
1.2. Sewage and storm water drainage
1.3. Planning of housing drainage
1.4. Environmental sanitation
1.5. Ventilation and air conditioning

Unit II: Drinking water treatment

1.1. Methods of water purification: flocculation, sedimentation, sedimentation with coagulation
1.2. Filtration: sand filters, pressure filters, horizontal filters
1.3. Disinfection and desalination of water
1.4. Chemical treatment: adsorption, gas stripping, ion exchange
1.5. Reverse osmosis and distillation

Unit III: Sewage treatment

1.1. Wastewater treatment plants: Concept, methods and design
   a. Primary
   b. Secondary
   c. Tertiary
1.2. Sludge and its disposal techniques
1.3. Natural methods of sewage disposal
1.4. Biology of sewage treatment
1.5. Reclamation and reuse of industrial and domestic wastewater

Unit IV: Solid and hazardous waste management

1.1. Solid wastes: sources, generation and their characteristics
1.1. Hazardous waste: sources and generation and their characteristics
1.2. Disposal and management of solid, industrial and hazardous wastes,
1.3. Hospital waste management
1.4. Site remediation

ENS17402CR: Biodiversity and Resource Management (04 credits)

Unit I: Biogeography

1.1. Geographical classification and zones
1.2. Major biomes of the world: Distribution and characteristic features
1.3. Zoogeographic realms of the world: Palaearctic, nearctic, neotropical, oriental, australian and african
1.4. Dispersal: Means, modes and barriers, island life
1.5. Migrations

Unit II: Biodiversity

1.1. Biodiversity: Status and importance, India as a mega-diversity nation
1.2. Endemism: Factors controlling distribution of flora and fauna
1.3. Hot Spots and cold spots, concept of native and exotic species
1.4. Biodiversity decline: Drivers of change and pressures
1.5. Threatened species categories of IUCN; concept of extinction threshold and extinction debt

Unit III: Biodiversity Management

1.1. Forest conservation: social forestry and joint forest management
1.2. Management of rangelands
1.3. Fishery resource management
1.4. Monitoring and management of bio-diversity
1.5. Biodiversity Conservation
   a. In-situ conservation: National parks, sanctuaries, biosphere reserves, ramsar Sites
   b. Ex-situ conservation: botanical gardens, zoological parks, zoos, seed banks, in-vitro conservation

Unit IV: Management of natural resources

1.1.Concept and strategies of sustainable development
1.2.Management of mineral resources
1.3.Management of fresh water resources
1.4.Energy crisis and conservation of energy resources
1.5.Concept of ecological footprint and carbon sequestration

ENS17403CR: Project Work (04 credits)

The project work shall be of practical nature and the candidate has to carry out the project work related to environment under the supervision of concerned teacher.

The distribution should be as follows:

- **Part I:** Identification of problem area and general description
- **Part II:** Study of specific literature in detail pertaining to the statement of the problem
- **Part III:** Developing a solution, methodology or proposing a hypothesis to solve the problem
- **Part IV:** Experimental analysis, results, discussion, conclusion and recommendations

Each student has to submit the dissertation of the project work for evaluation. The student has to give seminar (internal) and vivo voce (external) of the project work.

1.3. Landscape: Structure and processes
1.4. Tools and approaches in landscape ecology
1.5. Design of conservation reserves

ENS14404EA: Project Work **(08 credits)**

It is a special paper where a candidate carries out the application of knowledge in solving/ studying/ exploring a real life/ difficult problem in a creative way. The project work shall be of 8 credits. The project work shall be discipline centric and the candidate has to study the project work on his own with an advisory support by the concerned teacher.

The distribution should be as follows:

- **Part I:** Identification of problem area and literature survey
- **Part II:** Study of specific literature in detail pertaining to the statement of the problem
- **Part III:** Developing a solution, methodology or proposing a hypothesis to solve the problem
- **Part IV:** Experimental analysis, results, discussion, conclusion and recommendations

ENS14405EA: Environmental Biotechnology **(04 credits)**

Credit I: Introduction to environmental biotechnology **(16 hrs)**
1.1. Biotechnology
  a. Concept and environmental relevance
  b. Environmental risks
1.2. Biotechnology in Pollution control
1.3. Genetically modified organisms and bio-safety: A general account.
1.4. Environmental genomics: A key to understanding biology, pathophysiology and disease
1.5. Molecular taxonomy: Documenting biodiversity by DNA barcoding

Credit II: Eco-friendly role of animals **(16 hrs)**
1.1. Vermiculture technology
  a. Earth worms and soil productivity
  b. Earthworm culture and vermi-composting
1.2. Aquaculture improvement through biotechnology
1.3. Fish farming through biological wastes
1.4. Stem cell and animal cloning
1.5. Biological control of insects -definition, principles and control mechanisms

Credit III: In-vitro storage of plants **(16 hrs)**
1.1. Tissue culture: Concept, importance and methodology
1.2. Micropropagation techniques and application
1.3. Conservation: Short term, medium term and long term
1.4. Recent developments in cryopreservation

1.2.Theory and practice of managing the establishment, composition, and development of the forest
1.3.Urban forest ecology
1.4. Agro-ecosystems: Concept, structural and functional components
1.5. Role of biodiversity in agro-ecosystems, Food security and agriculture

Unit IV: Desert and grassland ecology
1.1. Ecological complexity of the desert commies
1.2. fauna and flora of the deserts
1.3. Ladakh cold desert
1.4. Grasslands ecology: evolution and types
1.5. Biodiversity and conservation in grasslands

ENS17406DCE: Environmental Planning and Auditing (02 credits)

Unit I
1.1.Environmental planning – importance and objectives
1.2.Land use planning
1.3.Urban development and environmental planning
1.4.Rural development and environmental planning
1.5. Role of ethics, aesthetics and science in environmental planning
Unit II
1.1.Principles and guidelines of environmental auditing
1.2.Preparation of environmental audit report
1.3.Waste audit procedures – sources, types and management of wastes
1.4.ISO 9001 and 9002
1.5.ISO 14000

ENS17407DCE: Restoration Ecology (02 credits)

Unit I: Concepts in restoration ecology
1.1. The basic principles and concepts of restoration ecology
1.2. Characteristics of degraded and restored ecosystems
1.3. Ecological indicators in restoration
1.4. Theory and practice of restoring animal and plant diversity
1.5. Ecological principles of the restoration of native ecosystems

Unit II: Restoration planning
1.1. Goals and objectives
1.2. Adaptive management and monitoring
1.3. Ethics of restoration
1.4. Role of public-private partnership in restoration
1.5. Measuring progress and success of restoration programs

1.2. Methods of sampling an area: Line transect, belt transect, quadrat, pin frame (point quadrat), permanent quadrat
1.3. Mark – Recapture method
1.4. Radio telemetry in estimation of animal movement
1.5. Data transformations, boot-strap and jack-knife procedure

ENS14407EO: Industrial Ecology & Sustainability (04 credits)

Credit I: Industrial ecology
1.1. Introduction to industrial ecology and its relation to the concept of sustainability
1.2. Principles and objectives of industrial ecology
1.3. Industrial symbiosis, industrial ecosystems and eco industrial parks
1.4. Ecology and biomimicry
1.5. Future and challenges of industrial ecology

Credit II: Agriculture meteorology (16 hrs)
1.1. Agro-climatic classifications
1.2. Important agro-meteorological parameters
1.3. Influence of weather and climate on agriculture
1.4. Applications of remote sensing techniques in agricultural meteorology
1.5. Agricultural droughts and food shortage

Credit III: Sustainable development (16 hrs)
1.1. Concept and strategies
1.2. Brundtland commission (Agenda 21)
1.3. Changes in institutional and environmental governance framework
1.4. Moving towards sustainability: An Indian perspective
1.5. Landmark events in sustainability

Credit IV: Environmental ethics (16 hrs)
1.1. Environmental ethics and philosophy: Introduction
1.2. Theories of environmental ethics and philosophy
1.3. Different schools of thought vis-à-vis nature and environmental management
1.4. Ethics in society: Responsibility for environmental degradation
1.5. Eco-centric theories of nature: Deep ecology and animal right theories, environmental rights, environmental racism, SD

Bibliography

- Biodiversity and Conservation. Michael J. Jeffries
- Environmental Biotechnology and Cleaner Bioprocesses. Eugenia J. Olguin, Gloria Sanchez, Elizabeth Hernandez
- Freshwater Aquaculture: R.K. Rath
- Pollution – Ecology and Biotreatment. Mc Eldowney and Waile

- Ponds and Fishculture. C.B. Hall
- Plant Tissue Culture. A.S. Islam
- Aquaculture and Fisheries Biotechnology – Genetic Approaches. R.A. Dunham
- Environmental Geology: Principles & Practice. Fred G. Bell
- Physical Geology. Monroe & Wicander
- Environmental Science. Cunningham, Saigo
- Concepts of Ecology. E.J. Kormondy
- River Jhelum, Kashmir Valley. L. Nyman
- Marine Fisheries Resources. Imtiaz Khan
- Natural Resources and Environmental Technology. Jasper S Lee
- Wildlife Wilderness. G.A. Bhat
- Wetland and water resource modeling and assessment- A watershed perspective. Wei Ji
- Wetlands Monitoring Modeling and Management. Tomasz Okruszko, Edward Maltby, Ian Szatytowicz, Dorota Swiatek and Wiktor Kotowski
- Watershed and drainage. Drick Deep
- Range ecology. Humphrey
- Flowers of the Himalaya. Adam Stainton
- Wildlife resources. Anderson
- Applied Fisheries science. S M Shafi
- Concepts of Ecology. E.J. Kormondy
- Geosystems- An Introduction to Physical Geography. Robert W. Christopherson
- Geoenvironmental Sustainabilty. Yong, R.N., Mulligam, C.N. and Fuke, M.
- Principles of Crop Production. Acquaah, G.
- Natural Resources. Holecheck, J.L., Cole, R.A., Fisher, J.T. and Valdez, R.
- Forest restoration in landscapes – Beyond planting trees. Mansourian, S., Vallauri, D. and Daudley, N. (Editors)
- Utilization of Forest Resources. Wadoo, M.S.
- Limnology. Wetzel, R.G.
- Lakes Handbook. O'Sullivan, P.E. and Reynolds, C.S.
- Groundwater Science. Fitts, C.R.
- Environmental Science. Botkin, D.B. and Keller, E.A.
- Environmental Science. Enger and Smith
- Basics of Environmental Science. Michael Allaby
- Environmental Science. Cunningham & Saigo
- Environmental Science. Tyler Miller
- Environmental Sciences (System and Solutions). Mckinney and Schoch

General Instructions for the Candidates

1. The semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core.
3. A candidate has compulsorily to opt for Paper ENS-AEP4 (8 credits) & has a choice to opt for any 4 credits (1 paper) out of the remaining 8 credits (2 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

Credit IV: Environmental economics **(16 hrs)**

1.1. Environmental economics: Definition and scope
1.2. Population, poverty and environment
1.3. Concept of intangibles and externalities
1.4. Environmental evaluation methods: Hedonic pricing, contingent evaluation and household production function
1.5. Carbon credits and trading

ENS14108EO: Plant morphogenesis, Cyto-genotoxicity & Herbal Medicine (04 credits)

Credit I: Plant morphogenesis and regeneration **(16 hrs)**

1.1. Initiation, nutrition and maintenance of plant cell and tissue culture
1.2. Cellular totipotency, initiation of callus cultures and its characteristics
1.3. Cell differentiation and organogenesis
1.4. Suspension culture
1.5. Tissue culture studies of some threatened medicinal plants of Kashmir Himalaya

Credit II: Herbal medicine and health care **(16 hrs)**

1.1. Traditional Herbal Medicines for Healthcare and Management of Human diseases
1.2. Medicinal and aromatic materials from plants
1.3. Benefits of Medicinal and aromatic plant materials
1.4. Industrial utilization of medicinal plants
1.5. Phytochemical and anti microbial studies of some medicinal plants

Credit III: Cyto-genotoxicity **(16 hrs)**

1.1. Necrosis, apoptosis and inflammation
1.2. Somatic and genetic risk of environmental pollutants.
1.3. Cancer latency, threshold and non-threshold model of cancer
1.4. Mechanism of chemical carcinogens (free radicals and alkylating agents)
1.5. Classification of carcinogens (physical, chemical and biological agent)

Credit IV: Toxicogenomics (Testing protocols) **(16 hrs)**

1.1. Ames test and micronucleus test
1.2. Chromatid and chromosome aberration
1.3. Screening, tier testing and test batteries for mutagenicity testing
1.4. FISH technique
1.5. Use of Comet assay in environmental toxicology

Bibliography

- Environmental Science. Botkin, Keller
- Environmental Science. Cunningham, Saigo
- Environmental Science. Jackson & Jackson

- Environmental Science. Tyler Miller
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Physical Geology. Monroe & Wicander
- Concepts of Ecology. E.J. Kormondy
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Environment: Principles & Applications. Chris Park.
- Earth Systems. W.G. Ernst
- Environmental Science - Physical Principles & Applications. Boeker & Grondelle
- Fundamentals of Physical Environment. Briggs, Smithson, Addison & Atkinson
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Geosystems: An Introduction to Physical Geography. Robert W. Christopherson
- Introducing Physical Geography. Alan Starhler & Arthur Starhler
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Soils in our Environment. Miller and Gardiner
- Fundamentals of Soils. J. Gerrard
- Environmental Science. Enger and Smith
- Basics of Environmental Science. Michael Allaby
- Principles of Environmental Science. Cummingham and Cunningham
- Environmental Sciences (System and Solutions). Mckinney and Schoch
- Principles of atmospheric physics and chemistry. Goody
- Smoke, Dust and Haze. S K Friedlander
- General Climatology. H. J. Critchfield
- Environmental Chemistry. IAN Williams
- Environmental Chemistry. A. K. De
- Environmental Chemistry. Stanley E. Manahan
- An Introduction to Analytical Chemistry. S.A. Iqbal & M. Satake
- Chromatography of Environmental Hazards. Lawrence Fishbein
- Principles of Biochemistry. Wilson Walker
- Electron Spin Resonance. J.E. Wertz And J.R. Bolton
- Analytical Chemistry. D. Kealey And P.J. Haines
- Text Book of Quantitative Chemical Analysis. G.H. Jeffery, J. Basset, J. Mendham and R.C. Denney
- The Surface Chemistry of Soils. Garrison Sposito
- The Nature & Properties of Soils. Brady & Weil
- Soils in our Environment. Miller and Gardiner
- Soil Genesis and Classification. Boul, Hole & Mccacken
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Text Book Of Limnology. Gerald A. Cole
- Limnology. R. G. Wetzel
- Limnology. Jacobson
- A Treatise on Limnology (Vol I – III). G. E. Hutchinson
- Limnology. Goldman and Horne
- Limnology. P. S. Welch
- Soil in the environment. Daniel Hillel
- Weathering (An introduction to scientific principles). Bland and Rolls
- Soil fertility and fertilizers. Havlin et al.
- Soil erosion and its control. R P C Morgan.
- Soil properties. Liu and Evett
- Soil science and management. Edward J Plaster
- Soils (An introduction). Singer and Munns
- Basic concept of environmental chemistry. Des W Connel
- Basic physical chemistry of the atmospheric science. Peter V Hobbs

- Environmental chemistry. Fritz Helmet
- Introductory chemistry for environmental science. Harrison and De Mora
- An introduction to environmental chemistry. Andrews et al.
- Stream ecology. Barness and Mishall
- Analytical mass spectrometery. Budde
- Primary Productivity of the Biosphere. Helmut Lieth & Robert H. Whittaker
- Tropical Ecosystems & Ecological Concepts. Patnick L. Osborne
- Concepts of Ecology. E.J. Kormondy
- Ecology & Environmental Management. C.C. Park
- Ecology of a Changing Planet. Mark B. Bush
- Ecology for Environmental Sciences: Biosphere, Ecosystems & Man. J. M. Anderson
- Fundamentals of Ecology. E.P. Odum
- Instant Notes in Ecology. Mackenzie, Ball & Virder
- Primer of Ecological Theory. Jonathan Roughgarden
- Ecology with special reference to Animals and Man. S. Charles, Kendeigh
- Evolutionary Ecology. Eric R. Pianka
- A Primer of Ecology. Nichloas J. Gotelli
- Ecology Theories and Applications. Peter Stiling
- Applied Ecology and Natural Resource Management. Guy R. Mcpherson and Stephen Destefano
- Population Ecology. Begon & Mortimer
- Geosystems: An Introduction to Physical Geography. Robert W. Christopherson
- Physical Geology. Plummer, Mc. Geary, Carlson
- Physical Geology. Monroe & Wicander
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Introducing ecology. Cotgreave and Forseth
- Community ecology. Diamond and Case
- Community ecology. R J Putman
- Biodiversity and conservation. Michael J Jeffries
- Environmental Geology: Principles & Practice. Fred G. Bell
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- Economic Geography - A Study of Resources. Prithwish Roy
- Environmental Science. Cunningham, Saigo
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- The Global Casino. Nick Middleton
- Natural Hazard Mitigation. Godschalk, Beatley, Berke, Brower & Kaiser
- Active Tectonics. E. Keller & N.Pinter
- Environmental Chemistry. M. Satake & Y. Mido
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- Environmental Geography. Marsh, W.M. and Grossa, Jr. J.M.
- Environmental Oceanography. Abel, D.C. and Mc Connell, R.L.
- Resources of the Earth. Craig, J.R., Vaughan, D.J. and Skinner, B.J.
- Natural Hazards and Disasters. Hyndman, D. and Daudley, N. (Editors)
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- Mineralogy. Perkins, D. Assad, F.A. and LaMoreaux, J.W.
- Environmental Law, the Economy and Sustainable Development. Revesz, Sands and Stewart
- Higher Education in India. Mehraj-ud-Din
- Environmental Economics and Policy. Tietenberg
- Issues in Environmental Economics. Hanley and Roberts
- Importance of Wildlife Conservation from Islamic Perspective. H.S.A. Yahya
- Psychology. Jhon J. Seamon, Douglas and T. Kenrick
- Society in Focus – Introduction to Sociology. William E. Thompson and Joseph V. Hickey
- Clinical Approach to Rural Development. E.D. Setty
- Environmental psychology. Annete Bolger
- Environment and Society. Francis Moore
- Environmental Economics-A Critical Overview. Alan Gilpin
- The economics of the environment and natural resources. R.Quentin Graflon et al.

General Instructions for the Candidates

1. The first semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

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PHARMACEUTICS II

(BIOPHARMACEUTICS/PHARMACOKINETICS AND NOVEL DRUG DELIVERY SYSTEM)

1. **PHARMACOKINETIC MODELS**-
   One and two compartment models. , Pharmacokinetic parameters, Absorption rate constant, Biological half life, Apparent vo0lume of distribution, Renal clearance, Total body Clearance ,
   Pharmacokinetics of multiple dosing, Dosage regimen design, loading and maintenance doses.
   Kinetics of sustained-release and continuous blood levels.
2. **BIOAVAILABILITY AND BIOEQUIVALENCE**
   Objective , significance and factors affecting bioavailability and bio equivalence, study design and assessment methods for bioavailability and bioequivalence. correlation of in-vitro dissolution with in-vivo bioavailability. Statistical concepts in estimation of bioavailability and bioequivalence. Regulatory requirements.

3. **CONTROLLED DRUG DELIVERY SYSTEM**
   Theory of controlled release drug delivery systems, Release and diffusion of drugs from C.D.D.S., General methods of design and evaluation of CDDS, Carriers for drug delivery systems, Prodrugs, Physical, chemical and biomedical engineering Approach to Achieve controlled drug delivery.
4. **MICROENCAPSULATION**-
   Methods, kinetics of drug release from microcapsules, technology and applications.
5. **TRANSDERMAL DRUG DELIVERY SYSTEMS**- Theory, formulation and evaluation, ionotophoresis,

6. **IMPLANTS AND INSERTS**-
   Types, design and evaluation methods,
7. **OSMOTICALLY REGULATED SYSTEMS**
   General considerations, classification and development of osmotic pumps. Applications
8. **TARGETED DRUG DELIVERY SYSTEM.**
   Concept of drug targeting. importance in therapeutics, Methods in drug targeting, Drug immobilization techniques, nanoparticles, liposomes, niosomes, pharmacosomes and resealed erythrocytes, Dendrimers, multiple emulsions.
9. **ADVANCED CONCEPTS** in the design, development and production of sustained-release products.
10. **PRESENT STATUS AND SCOPE OF BIOTECHNOLOGY IN PHARMACY,** Production and applications of monoclonal antibodies, Fermentation characterization and optimization of ferme
    Types, design and operation of fermenters.

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PHARMACOLOGY-II

RECENT ADVANCES AND EMERGINT TRENDS IN PHARMACOLOGICAL SCIENCES.

Theory

1)DigestiveSystem
a) Pharmacotherapy of peptic ulcer, diarrhoea, constipation.
b) Agents affecting gastrointestinal water, Flux and motility: Emesis and antiemetics; Bile acids and Pancreatic enzymes
2. Therapy of Infectious diseases
a) General Principles, Antibacterial Drugs Sulphonamides, Quinolones, Penicillins, Cephalosporins, Tetracyclines, Chloramphenicol.
b) Drugs used in the chemotherapy of Protozoal infections: Malaria
c) Drugs used in the chemotherapy of Protozoal infections : Trypanosomiasis, Leishmaniasis, Amebiasis, Giardiasis, Trichomoniasis, and other Protozoal infections.
d) Drugs used in the chemotherapy of Helminthiasis
e) Drugs used in the chemotherapy of Leprosy, Tuberculosis, Fungal infections, Viral infections
f) Drugs used in the Chemotherapy of Neoplastic diseases
g) Immunomodulators : Immunosuppressive agents and Immunostimulants
h) Newer Chemotherapeutic agents
3. Hormones and Hormones Antagonists
a) Adenohypophyseal hormones and their Hypothalamic releasing factors.
b) Hormones of Posterior pituitary
c) Thyroid and Antithyroid drugs
d) Estrogens and Progestins, Antifertility agents
e) Androgens
f) Adrenocorticotropic hormones; Adrenocortical steroids and their synthetic analogs; Inhibitors of the synthesis and actions of adrenocortical hormones.
g) Insulin, oral hypoglycemic agents and the Pharmacology of pancreatic hormones.
h) Agents affecting Calcification and bone turnover:
Calcium phosphate, parathyroid hormones, vitamin D, Calcitonin and other compounds.
i) Vasopressin and other agents affecting the renal conservation of water.
4. Emerging Trends & Recent advances in:
a) Receptor and G-Protein
b) Cyclic neucleotides
c) TNF, Apoptosis
d) Ion channel modulators
e) Neurosteroids and Cannabinoids
f) Nitric oxide
g) ANF, Anti oxidants : Melatonin
h) Gene therapy
i) Neuropeptide, Substance P, Angiotensin II modulators.

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PHARMACEUTICAL CHEMISTRY-II CHEMISTRY OF NATURAL PRODUCTS

1. **Natural products as Leads for new pharmaceutical.**

2. The natural products obtained from terrestrial and microbial sources will be discussed in the light of various degradative and synthetic approaches supported by spectral data. Important members representing the following classes of natural products shall be discussed.

2.1 **ALKALOIDS**

General introduction and classification, isolation and purification methods, general methods employed for determining the structure of alkaloids, constitution of morphine, reserpine and quinine.

2.2 **STEROIDS**

General introduction, stereochemistry, nomenclature and structure elucidation of sterols (cholesterol), sapogenin (diosgenin) and cardiac glycosides.

2.3 **AMINO ACIDS AND PEPTIDES, NUCLEIC ACIDS :**

General introduction, synthesis of peptides and amino acids. End group analysis, structural features of Insulin, vasopressin and oxytocin, structural features of DNA & RNA.

2.4 **ANTIBIOTICS :**

Classification of antibiotics, structural details of penicillins and tetracyclines, polypeptide antibiotics.

2.5 **FLAVONOIDS :**

Detailed chemical account of rutin and quercetin.

2.6 **TRITERPENOIDS :**

A general chemical treatment and structural elucidation of terpenoids

2.7 **COUMARINS**

General methods of isolation and purification and structural determination of Xanthotoxin and psoralene.

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Books Recommended

1. I.L. Finar, Organic Chemistry, Vol.II, The English Language Books Society and Longman Group Limited.
2. G.A. Cordell, Introduction to Alkaloids, John Wiley and Sons, New York.
3. M.L. Wickery and B. Wickery, Secondary Plant Metabolism McMillan Press Ltd. London.
4. L.F. Fieser and M. Fieser, Steroids, Reinhold Publishing Co. NewYork.
5. K.B.G. Torsell, Natural Products Chemistry, John Wiley and Sons, New York.
6. J.B. Harborne, Phytochemical Methods, Chapman and Hall, London
7. Burger's Medicinal Chemistry and Drug Discovery, Vol. I. Principle and Practice, 5th, Edition, John Wiley Sons, New York.

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6. Narayanaswami S. (1997). Plant Cell and Tissue Culture, Madras Science Foundation, Madras.
7. Bajaj Y.P.S. “Biotechnology in Agriculture and Forestry-Volumes 4, 7, 8, 9, 15 (1988-91). Springer -Verlag, Berlin.
8. Takashashi N. (1986). Chemistry of Plant Hormones, CRC Press Inc., Florida
9. Gennaro AR (2000). Remington: The Science & Practice of Pharmacy, Lippincott Williams & Wilkins, Philadelphia.
10. Fitoterapia- (1980 onwards).
11. Planta Medica (1980 onwards).
12. Plant Cell, Tissue and Organ Culture (1980 onwards).
13. Journal of Ethnopharmacology (1980 onwards).
14. Journal of Natural Products (1970 onwards).
15.Phytochemistry(1970onwards).

PHARMACOGNOSY & PHYTOCHEMISTRY-II

PHYTOCHEMISTRY & BIOGENESIS

1. General methods of phytochemical & biological screening, isolation and purification of plant constituents.
2. Natural sources, extraction, purification, isolation and characterization of the following Phytopharmaceuticals.
Alkaloids : Morphine, Quinine
Glycosides : Sennosides, Glycyrrhizine, Asiaticosides, Diosgenin, Solasodine, Rutin
3. Industrially important volatile oils: Natural occurrence, their chemistry, ontogenic variation and trade.
4. Methods of investigation of biogenetic pathways.
5. Biogenetic pathways for the production of phytopharmaceuticals, such as Alkylamine (Ephedra), Pyridine, Piperidine (Lobelia), Tropane (Belladonna), Quinoline (Cinchona), Isoquinoline (Opium), Diterpene (Aconite), Indole (Ergot), Cardiac glycosides, Coumarins and Flavones.
6. Study of some herbal formulation as drug and cosmetics.

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BOOK RECOMMENDED

1. Evans WC (2002) Trease & Evans’ Pharmacognosy, W.B. Saunders & Co., London.
2. Natural Products for Plants by Kaufmann, CRC Press New York.
3.Cultivation and Utilization of Medicinal & Aromatic Plants by C.K. Atal and B.M. Kapur, R.R.L. Jammu.
4. Pharmacognosy by Tyler and Brady, Lea & Febiger, Philadelphia.
5. Herbal Medicines by Jonne Bernes, Pharmaceutical Press, London.
6. Medicinal Plants in Skincare by Sushil Kumar, CIMAP, Lucknow.
7. Nakanishi K (1977). Chemistry of Natural Products, Kodansha Book Publishing Company, Osaka (Japan).

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(MPP-II) PHARMACY PRACTICE- II

APPLIED PHARMACOTHERAPEUTICS INCLUDING PATHOPHYSIOLOGY

Pathophysiology and applied therapeutics of diseases associated with following system/diseases with special reference to the drugs of choice.

1.**Cardiovascular system**- Hypertension, congestive cardiac failure ischaemic heart disease, arrhythmias. Hyperlipidemias.

2. Respiratory system-Asthama, chronic obstructive airways disease, drug induced pulmonary diseases.

3. Renal system-Acute renal failure, chronic renal failure, renal dialysis and transplantation, drug dosing in renal impairment, drug induced renal disease, electrolytes and fluid balance.

4.Haematological Disease- Anaemaia, thrombo-embolic disorder, drug induced haematological disorder.

5.**Endocrine system-** Diabetes, thyroid diseases, oral contraceptive, hormone replacement therapy, osteoporosis.

6.Nervous system- Epilespsy, Parkinson's disease, stroke and transient ischaemic attacks, headache,Alzheimer's Huntington's chorea.

7. Psychiatric disorders- Schizophrenia, depression, anxiety disorders, sleep disorder.

8. Gastrointestinal system- Ulcer disease, inflammatory bowel diseases, hepatitis, jaundice, drug dosing in liver dysfunction, diarrhoea and constipation.

9. Pathophysiology of Inflammation and repair, Immunology basic principles.

10. Rheumatic diseases- Rheumatold arthritis, gout, junvenile rheumatoid arthritis.

11. Infectious diseases- Meningitis, respiratory tract infections, gastroenteritis, pneumonia, bacterial endocarditis, septicaemia, otitis media, urinary tract infections, tuberculosis, leprosy, protozoal infections, helmenthiasis, HIV, opportunistic infections, and fungal infections.

12.Skin and Sexually transmitted diseases- Psoriasis, acne, eczema, scabies, syphilis and gonorhoea.

13.Oncology cell cycle General principles of Cancer Chemotherapy- Commonly used cytotoxic drugs. Chemotherapy of lung cancer, breast cancer, head and neck cancer, prostate cancer, cervical cancer, haematological malignancies.

14. Ophthamology- Galucoma and eye infections.

15. Pain management- Pain pathways, analgesics and NSAIDs , opiates, local anaesthetics, neuralgia including trigeminal and glosso-pharyngeal neuralgias.

16. Nutrition Malnutrition and deficiency states- Enteral and parentral nutrition.

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