P.G. Department of Environmental Science, University of Kashmir,Srinagar,190006

M. Sc. Programme in Environmental Science (2012)

Course Contents

The two year (four semester) postgraduate course in Environmental Science will be based on sixteen theory papers (four in each semester), four laboratory courses (one each in the first, second, third and fourth semesters) and one dissertation. Each theory paper will be of 100 (80 marks for External Examination and 20 marks for internal assessment) marks and will comprise four units. In each paper, questions will be distributed throughout the whole syllabus. The question paper will be divided into three sections. Section A will contain eight very brief answer (10 – 20 words each) type questions, each carrying 2 marks. Section B will contain four medium answer (200 – 250 words) type questions, each carrying 8 marks. Section C will contain four long answer (400 – 500 words) type questions, 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.

Laboratory courses for ENS 111,211,311 will be of 200 marks each (160 for the external examination and 40 for Internal Assessment).and will cover theory papers of respective semesters However, ENS 411 will be of two components viz Laboratory course and Dissertation. The Laboratory course will carry 50 marks (40 for external examination and 10 for internal assessment) while as the Dissertation will carry 150 marks (90 for the evaluation of the dissertation, 30 for Viva Voce and 30 for Internal Assessment).The Dissertation will be based on the report of the project allotted to the student during the first-second semester of the course. The student will have to submit the Dissertation at the end of the fourth semester before the theory examination. The Viva Voce test will be conducted by the Head of the University Department, External Examiner and the Project Supervisor. However, the student will have to pass both the components of ENS 411 together.

FIRST SEMESTER (2012)

The First Semester will include four theory courses (ENS 101 – 104) and one Laboratory Course (ENS 111). The course contents of the four theory papers are given hereunder. The laboratory course will be based on the syllabi of all the four theory courses.

Paper ENS 101: Fundamentals of Environmental Science

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: Environment (12 hrs. approx.)

1.1. Definition, principle and scope of Environmental Science
1.2. Origin and evolution of Earth
1.3. Man in environment
1.4. Environment on other planets

Unit II: Components of Environment (12 hrs. approx.)

2.1. Atmosphere: Structure and composition
2.2. Hydrosphere: Hydrological cycle
2.3. Lithosphere: Structure and composition
2.4. Biosphere: its components

Unit III: Meteorology (12 hrs. approx.)

3.1. Meteorological parameters: Pressure, Temperature, Precipitation, Humidity, Radiation and Wind
3.2. Heat transferring processes, Atmospheric stability, Inversions, Mixing heights and Wind roses
3.3. Climate of India and Monsoons
3.4. Climate of J&K and Western disturbances
3.5. Tropical Cyclones, El Nino and La Nina

Unit IV: Soil and Water (12 hrs. approx.)

4.1. World Soil types
4.2. Land use patterns
4.3. Surface and ground water resources: global consumption pattern
4.4. Macro and Micronutrients in water and sediments

Bibliography

1. Environmental Science: Botkin, Keller
2. Environmental Science: Cunningham, Saigo
3. Environmental Science: Jackson & Jackson
4. Environmental Science: Tyler Miller
5. Essentials Of Geology: Chernicoff, Fox, Venkatakrishnan
6. Physical Geology: Monroe & Wicander
7. Concepts Of Ecology: E.J. Kormondy
8. Atmosphere, Weather & Climate: R.G. Barry & R.J. Chorley
9. Environment Principles & Applications: Chris Park.
10. Environmental Chemistry: S.C. Bhatia
11. Earth Systems: W.G. Ernst
12. Ecology & Environment: P.D. Sharma
13. Environmental Science Physical Principles & Applications: Boeker & Grondelle
14. Fundamentals Of Physical Environment. Briggs, Smithson, Addison & Atkinson
15. Global & General Environment: H.D. Kumar, Swati Kumar
16. Atmosphere, Weather & Climate: R.G. Barry & R.J. Chorley
17. Geosystems: An Introduction To Physical Geography: Robert W. Christopherson
18. Introducing Physical Geography: Alan Starhler & Arthur Starhler
19. Earths Dynamic Systems: W.K. Hamblin & E.H. Christiansen
20. Soils In Our Environment: Miller And Gardiner
21. Fundamentals of Soils. J. Gerrard
22. Environmental science: Enger and smith
23. Basics of environmental science: Michael Allaby
24. Principles of environmental science: cummingham and Cunningham.
25. Environmental sciences (system and solutions): Mckinney and Schoch.
26. Principles of atmospheric physics and chemistry: Goody.
27. Global warming and climate change: Dr. S K Agarwal.
28. Atmospheric pollution and climate change: Dr. P C Sinha.
29. Smoke, dust and Haze: S K Friedlander.
30. Ground water resources of india: Jeet.
31. Water: Rajvaidya and Markanda.
32. General climatology : H. J. critchfield.

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

BIBLIOGRAPHY

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.

39. Analytical mass spectrometery: Budde.

Paper ENS 103: Environmental Biology

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: Ecosystem Dynamics (12 hrs. approx.)

1.1. Structure, types and function of ecosystem
1.2. Ecosystem cybernetics
1.3. Primary productivity
1.4. Secondary productivity
1.5. Energy flow and laws of thermodynamics; energy models and energy relations in ecosystems

Unit II: Populations & Communities (12 hrs. approx.)

2.1. Characteristics of populations
2.2. Population growth
2.3. Population interactions
2.4. Population regulation: density dependent and density independent
2.5. Concept and characteristics of communities
2.6. Community Development
   a. Types of succession
   b. Climax characterisation

Unit III: Biogeography (12 hrs. approx.)

3.1. Major biomes of the world: distribution and characteristic features-Forest, Grassland, woodland, chaparral, tundra, desert, marine
3.2. Zoogeographic realms of the world: Palaearctic, Nearctic, Neotropical, Oriental, Australian and African.
3.3. Island life: Madagascar and New Zealand.
3.4. Dispersal: means, modes and barriers
3.5. Migrations

Unit IV: Biodiversity (12 hrs. approx.)

4.1. Biodiversity: status and importance, India as a mega-diversity nation
4.2. Endemism- factors controlling distribution of flora and fauna
4.3. Concept of Native and Exotic species
4.4. Hot Spots and Cold spots

4.5. Biodiversity Decline: Drivers of change and pressures
4.6. Threatened species categories of IUCN
4.7. Concept of extinction threshold and extinction debt

BIBLIOGRAPHY

1. Primary Productivity Of The Biosphere: Helmut Lieth & Robert H. Whittaker
2. Tropical Ecosystems & Ecological Concepts: Patnick L. Osborne
3. Concepts Of Ecology: E.J. Kormondy
4. Ecology & Environmental Management: C.C. Park
5. Ecology Of A Changing Planet: Mark B. Bush
6. Ecology For Environmental Sciences: Biosphere, Ecosystems & Man: J. M. Anderson
7. Ecology & Environment: P.D. Sharma
8. Fundamentals Of Ecology: E.P. Odum
9. Population Ecology: P.S. Aaradhana
10. Instant Notes In Ecology: Mackenzie, Ball & Virder
11. Primer Of Ecological Theory: Jonathan Roughgarden
12. Ecology With Special Reference To Animals And Man: S. Charles, Kendeigh
13. Evolutionary Ecology: Eric R. Pianka
14. A Primer Of Ecology: Nichloas J. Gotelli
15. Ecology Theories And Applications: Peter Stiling
16. Community Ecology: P.S. Aaradhana
17. Applied Ecology And Natural Resource Management: Guy R. Mcpherson And Stephen Destefano
18. Population Ecology. Begon & Mortimer
19. Geosystems: An Introduction To Physical Geography: Robert W. Christopherson
20. Biodiversity: K.C. Agarwal
21. Physical Geology: Plummer, Mc. Geary, Carlson
22. Physical Geology: Monroe & Wicander
23. Essentials Of Geology: Chernicoff, Fox, Venkatakrishnan
24. Earths Dynamic Systems: W.K. Hamblin & E.H. Christiansen
25. Essential environmental studies: Mishra and Panday.
26. Introducing ecology: Cotgreave and Forseth.
27. Community ecology: Diamond and Case.
28. Community ecology: R J Putman.
29. Biodiversity: Rallapalli and Bali.
30. Biodiversity and ecosystem conservation: Ashish Dutta.
31. Biodiversity conservation and sustainable development: Khan and Shishodia.
32. Global biodiversity and conservation measures: Khan and Al Ajmi.
33. Biodiversity and conservation: Michael J Jeffries.

Paper 104: Natural Resources

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: Water & Mineral resources (12 hrs. approx.)

1.1. Water resources of India with special reference to Kashmir
1.2. Metals and minerals from land and oceans and their global distribution
1.3. Metals and mineral deposits in India
1.4. Metal and Mineral resources of Jammu and Kashmir

Unit II: Bio-resources (12 hrs. approx.)

2.1. Animal Resources: current status with special reference to India
2.2. Forest resources of India: Timber and Non Timber
2.3. Range lands
2.4. Fishery resources of India
    a. Inland
    b. Marine
2.5. Fishery resources of J&K

Unit III: Energy resources (12 hrs. approx.)

3.1. Renewable Energy Resources
    3.1.1. Solar energy
    3.1.2. Wind and tidal energy
    3.1.3. Geo thermal energy
    3.1.4. Hydropower energy
    3.1.5. Energy from biomass
    3.1.6. Hydrogen as a source of energy
3.2. Non-renewable energy Resources
    3.2.1. Fossil fuels and their global distribution
        a. Coal
        b. Petroleum
        c. Natural gas
    3.2.2. Nuclear energy

Unit IV: Himalayan Resources (12 hrs. approx.)

4.1. Glacier resources of the Himalayas
4.2. Forests and Forestry in Himalayas

4.3. Medicinal plants of the Himalayas
4.4. Flora and Fauna of Jammu & Kashmir
4.5. Energy resources of Jammu & Kashmir

BIBLIOGRAPHY

1. Resource Ecology: S. K. Agarwal.
2. Essentials Of Geology: Chernicoff, Fox, Venkatakrishnan
3. Environmental Geology: Principles & Practice : Fred G. Bell
4. Physical Geology: Monroe & Wicander
5. Economic Geography- A Study Of Resources: Prithwish Roy
6. Environmental Science: Cunningham, Saigo
7. Fish & Fisheries Of India: V.G. Jhingram
8. Concepts Of Indian Fisheries: K.C.Pandey
9. Concepts Of Ecology: E.J. Kormondy
10. River Jhelum, Kashmir Valley. L. Nyman
11. Introduction To Inland Fisheries: Kamaldeep Kaur & Asha Dhawan
12. Marine Fisheries Resources: Imtiaz Khan
13. Himalayan Fish And Fisheries: S.S.Negi
14. Natural Resources And Environmental Technology: Jasper S Lee
15. Economic Geography- A Study Of Resources: Prithwish Roy
16. Energy & Environment: H.V. Jadhav
17. Alternative Energy S. Vandaana
18. Solar Energy- The Infinite Source: G.K. Ghosh
19. Renewable Sources Of Energy And The Environment: Essam El. Hinnawi & Asit K. Biswas
20. Natural Resources And Environmental Technology: Jasper S Lee
21. Himalayan Glaciers: Naseerudin Ahmed, Sarwar Rais
22. Dynamics Of Mountain Geosystems: R.B. Singh
23. Himalayan Ecology: S. K. Chadha
24. Himalayan Ecology & Environment: A.B. Chaudhuri
25. Dynamic Himalaya: K.S. Valdiya
26. Himalayan Ecology: P.S. Aaradhana
27. Natural resources of Western Himalaya. A.K.Pandit
28. Wildlife Wilderness. G.A.Bhat
29. Range ecology: Humphrey
30. Essential environmental studies: Misra and Panday.
31. Indian forests, Forestery and wildlife:S S Negi.
32. Forestery and Forest Resources: V K Prabhakar.
33. Forest resources and biodiversity management: K C Bebarta.
34. Energy resources and environment: V K Prabhakar
35. Alternative energy: Vandana S.
36. Flowers of the Himalaya: Adam Stainton.
37. Bioresource ecology: Ananthakrishnan.
38. Wildlife resources: Anderson.
39. Wild life in India: V B Sharma.
40. Fish catching: T K Shreestha.
41. Applied Fisheries science: S M Shafi.
42. A text book of aquaculture: Reddy and Rao.

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.

SECOND SEMESTER (2012)

The Second Semester will include four theory courses (ENS 201 – 204) and one Laboratory Course (ENS 211). The course contents of the four theory papers are given hereunder. The laboratory course will be based on the syllabi of all the four theory courses.

Paper 201: Environmental Geo-science

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: Planet Earth (12 hrs. approx.)

1.1. Energy budget of the earth
1.2. Earth's thermal environment and seasons
1.3. Earth surface processes.
1.4. Continental drift: Plate tectonics and Neo-tectonics.
1.5. Concept of residence time and rate of natural cycles

Unit II: Natural Disasters (12 hrs. approx.)

2.1. Concept of natural disasters
2.2. Causes and environmental consequences of
   a. Earth quakes and Tsunami
   b. Floods and droughts
   c. Landslides
   d. Volcanoes
   e. Cloudbursts
2.3. Disaster management: preparedness, response and rehabilitation and failures(case studies)

Unit III: Marine Systems (12 hrs. approx.)

3.1. Composition of seawater
3.2. Marine zones
3.3. Marine resources and their recycling
3.4. Ice sheets and fluctuations of seawater
3.5. Ocean conveyor belt

Unit IV: Geochemistry (12 hrs. approx.)

4.1. Concept of major trace and REE

4.2. Classification of trace elements
4.3. Mobility of trace elements
4.4. Geochemical cycles - C, P, N, S

BIBLIOGRAPHY

1. Microclimate The Biological Environment: 2nd Ed. Normal J. Rosenverg, Blaine L. Blad, Shashi B. Verma
2. Atmospheric Change:Graedel And Crutzen
3. Atmospheric, Weather And Climate: R.G. Barrey And R.J. Chorley
4. Concepts Of Ecology: E.J. Kormondy
5. Geosystems- An Introduction To Physical Geography: Robert W. Christopherson
6. Hydrological Disasters: P.C. Sinha
7. Physical Geology: Plummer, Mc. Greary, Carlson
8. Essentials Of Geology: Wicander & Monroe
9. Earths Dynamic Systems: W.K. Hamblin & E.H. Christiansen
10. The Global Casino: Nick Middleton
11. Natural Hazard Mitigation: Godschalk, Beatley, Berke, Brower & Kaiser
12. Active Tectonics: E. Keller & N.Pinter
13. Essentials Of Geology: Chernicoff, Fox, Venkatakrishnan
14. Environmental Chemistry: M. Satake & Y. Mido
15. Earths Dynamic Systems: W.K. Hamblin & E.H. Christiansen
16. Physical Geology: Wicander & Monroe
17. Environmental Chemistry: B.K. Sharma
18. Environmental Chemistry: A.K.De
19. Environmental Chemistry:Stanley E. Manahan
20. Environmental Chemistry: M. Satake, Y. Mido, M.S. Sethi & S. A. Iqbal
21. Environmental Chemistry: Ian Williams
22. Our Geologic Environment. Blatt, H.
23. Environment. Raven, Berg and Johnson.
24. Environmental Science. Botkin, D.B. and Keller, E.A.
25. Environmental Science. Nebel, B.J. and Wright, R.T.
26. Environmental Geography. Marsh, W.M. and Grossa, Jr. J.M.
27. Oceanology. Gupta, H.K.
28. Environmental Oceanography. Abel, D.C. and Mc Connell, R.L.
29. Resources of the Earth. Craig, J.R., Vaughan, D.J. and Skinner, B.J.
30. Natural Hazards and Disasters. Hyndman, D. and Daudley, N. (Editors)
31. Towards Basics of Natural Disaster Reduction. Sinha, D.K.
32. Encyclopedia of Disaster Management. Goel, S.L.
33. Environmental Geochemistry. Eby, G.N.
34. Environmental Hydrogeology. Soliman, M.M., LaMoreaux, P.E., Memon, B.A.,
35. Mineralogy. Perkins, D. Assad, F.A. and LaMoreaux, J.W.

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.

Paper 203: Environmental Pollution and its Control - I
(Air, Noise and Radioactive Pollution)

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: Atmospheric Pollution (12 hrs. approx.)

1.1. Sources, classification and properties of primary and secondary air pollutants
1.2. Pollutant behavior in atmosphere
1.3. Smog and acid rain
1.4. Ozone layer depletion
1.5. Green house gases and Climate change
1.6. Effects of air pollutants on ecosystem

Unit II: Control of Atmospheric Pollution (12 hrs. approx.)

2.1. Indoor air pollution and its control: smoke, HCs, particulate matter, Radon
2.2. Control of green house gases
2.3. Monitoring of air pollution: SOx, NOx, CO, SPM and hydrocarbon
2.4. Control of gaseous air pollution - SOx, NOx, CO
2.5. Control of particulate air pollution
2.6. Air quality standards

Unit III: Noise Pollution and its Control (12 hrs. approx.)

3.1. Basic physics related to sound
3.2. Super Sonic, Ultrasonic and Sonic Booms
3.3. Noise pollution - definition and sources
3.4. Measurement of Noise and sound pressure level,
3.5. Impact of noise on human health
3.6. Noise control and abatement measures

Unit IV: Thermal and Radioactive Pollution (12 hrs. approx.)

4.1. Thermal pollution: causes and consequences
4.2. Radioactive pollution: causes and consequences
4.3. Types of radioactive pollutants and their sources.
4.4. Radioactive waste management

BIBLIOGRAPHY

1. Understanding Our Environment: M.S. Sethi, Inderjeet Kaur Singh
2. Environmental Science & Technology: G.N. Pandey
3. Fundamentals Of Environmental Pollution: Hamid Rizvi
4. Environmental Pollution: T. Katyal & M. Satake
5. A Textbook Of Environmental Chemistry : O.D. Tyagi & M.Mehra
6. Environmental Chemistry: Stanley E. Manahan
7. Environmental Chemistry: S.C. Bhatia
8. Atmospheric Disasters: P.C. Sinha
9. Global Warming – A Science Of Climatic Change: Frances Draki
10. Automobile Pollution: S. K. Agarwal
11. Automobile Pollution: Satykush
12. Pollution Management: Vol. I S. K. Agarwal
13. Environmental Air Pollution: D. Prasad & M.L. Choudhary
14. Concepts Of Environment: P. D. Sharma
15. Environmental Chemistry: Fratz Helmet
16. Indoor Air Pollution: Richard Wadden & Peter Scheff
17. Air Pollution And Its Management: G. Gaur
18. Air Pollution And Plant Life: J.N. Bell & M. Treshow
19. Environmental Pollution: T. Katyal & M. Satake
20. Noise Pollution: G.K. Nagi, M.Dhillon, G. Dhaliwal
21. Pollution Management: Vol. 5 Noise Pollution S.K. Agarwal
22. Environmental Noise Pollution And Its Control: Chatwal, Mehra, Satake, Katyal, M. Katyal & T. Nagahiro
23. Noise Pollution And Its Management: G. Gaur
24. Basic concepts of Environmental Chemistry. Connell, D.W.
25. Atmosphere and Air Pollution Control Technologies. Khan, T.I.
26. Global Environmental Risk. Kasperson and Kasperson.
27. Global Environmental Change. Hidore, J.J.
28. Climate Change. Burroughs, W.J.
29. Global Warming. Johansen, B.E.
30. Global Warming. Brown, P.
31. Noise pollution and control strategy :S.P Singal
32. Noise Pollution : S.K Aggarwal
33. Environmental Noise pollution :V.K Prabhakar
34. Environmental Noise pollution (causes, evils, legislation and control):Vijendra Mahandiyan

Paper 204: Environmental pollution and its Control - II
(Land and Water pollution)

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: Soil Degradation **(12 hrs. approx.)**

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

Unit II: Control of Land Degradation **(12 hrs. approx.)**

2.1. Soil conservation and control of soil erosion
2.2. Desertification: causes, consequences and control
2.3. Waste lands and their reclamation
2.4. Sustainable agricultural practices
2.5. Integrated pest management

Unit III: Water Pollution **(12 hrs. approx.)**

3.1. Sources and types of water pollution
3.2. Lake eutrophication
3.3. Stream pollution
3.4. Petroleum hydrocarbons and marine pollution
3.5. Ground water pollution
3.6. Biocides and Heavy metals and their impact on aquatic life

Unit IV: Control of Water Pollution **(12 hrs. approx.)**

4.1. Water quality indices

4.2. Water and waste water standards
4.3. Control of eutrophication and restoration of lakes
4.4. Wetland conservation
4.5. Role of aquatic plants in pollution abatement
4.6. Control of Stream pollution

BIBLIOGRAPGY

1. Soils and the environment: An introduction. Wild, A.
2. Soils in Our Environment. Miller, R.W. and Donahue, R.L.
3. Fundamentals of soils. Gerrard, J.
4. The nature and properties of soils. Brady, N.C. and Weil, R.R.
5. Soil Erosion and its control. Morgan, R.P.C. (Editor.)
6. Soil in the environment. Hillel, D.
7. Soil Science and Management. Plaster, E.J.
8. Environmental Soil Science. Tan, K.H.
9. Soil and water contamination. van der Perk, M.
10. Soil fertility and fertilizers. Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, W.L.
11. Pollution Management. Agarwal, S.K.
12. Eco-Informatics. Agarwal, S.K.
13. Geoenvironmental Sustainabilty. Yong, R.N., Mulligam, C.N. and Fuke, M.
14. Green Technologies and Sustainable Agriculture. Kumar and Dubey.
15. Principles of Crop Production. Acquaah, G.
16. Natural Resources. Holecheck, J.L., Cole, R.A., Fisher, J.T. and Valdez, R.
17. Forest restoration in landscapes – Beyond planting trees. Mansourian, S., Vallauri, D. and Daudley, N. (Editors)
18. Utilization of Forest Resources. Wadoo, M.S.
19. Limnology. Wetzel, R.G.
20. Lakes Handbook. O'Sullivan, P.E. and Reynolds, C.S.
21. Groundwater Science. Fitts, C.R.
22. Groundwater and Surface Water Pollution. Liu, D.H.F. and Liptak, B.G.
23. Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication. IETC Technical Publication.
24. River Channel Management. Downs and Gregory.
25. Wetlands: Monitoring, Modelling and Management. Okruszko, T., Maltby, E., Szaltytowicz, J., swiatek, D. and Kotowski, W.
26. Creating freshwater wetlands. Hammer, D.A.
27. Primary Energy. Present Status and Future Prospectives. Thielheim, K.O. (Editor)
28. Environmental Engineering. Gilberts, M.
29. Environmental Engineering. Sincero, A.P. and Sincero, G.A.
30. Environmental Engineer's Handbook. Liu, D.H.F. and Liptak, B.G.
31. Wastewater Engineering. Metcalf and Eddy.
32. Water and Wastewater Technology. Hammer and Hammer.
33. Aquatic Weeds. Majid, F.Z.

34. Handbook of sustainable weed management. Singh, H.P., Batish, D.R. and Kohli, R.K. (Eds.)
35. Basic Environmental Technology. Nathenson, Jerry. A.

Laboratory Course ENS 211 (Second Semester)

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

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 in relation to eutrophication.
12. Qualitative and quantitative estimation of periphyton community in different aquatic habitats
13. Qualitative and quantitative analysis of zooplankton in relation to eutrophication.
14. Identification of biological indicators of pollution in terrestrial habitats.
15. Study of seed viability by germination and T.T. C. tests.
16. Study of leaf pigment by paper chromatography and TLC methods.
17. Comparative anatomical study of mesophytes, hydrophytes and xerophytes.
18. Chemical characterization of ground water
19. Identification and quantification of point sources of pollution in water bodies.
20. Study of dose – effect relationships in important toxicants/pollutants
21. Detection of some pesticides in vegetables and fruits.
22. Estimation of protein and carbohydrate content in biological samples.
23. Study of effect of detergents on plants.
24. Application of diversity indices in aquatic and terrestrial ecosystems
25. Spring and stream order classification

Note: The students are required to visit important subtropical and tropical aquatic and terrestrial habitats of the country so as to gain knowledge about the natural resources of the country. They are also required to have an on - the - site study of pollution from different industrial units in the country. The field study report will carry 30 marks (Field collection – 10 marks and Field Study Report – 20 marks) and will be assessed at the time of Practical examination.

THIRD SEMESTER (2012)

The Third Semester will include four theory courses (ENS 301 - 304) and one Laboratory Course (ENS 311). The course contents of the four Theory and one Practical paper are given hereunder.

Paper 301: Environmental Microbiology

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: Microbiology (12 hrs. approx.)

1.1. History and scope of microbiology
1.2. General account of micro-organisms
   a. Bacteria (archaebateria, eubacteria, actinomycetes, spirocheates and cynobacteria, mycoplasma)
   b. fungi, algae and viruses
   c. Protozoa
1.3. Interactions between microbes and other organisms

Unit II: Microbes and Environment (12 hrs. approx.)

2.1. Nature and function of micro-organisms in Soil, Water and Air
2.2. Microbial spoilage of food and its preservation
2.3. Microbial activity in sewage disposal
2.4. Application of micro-organisms in the control of
   a. Oil pollution
   b. Chemical pollution - pesticides, synthetic polymers, and metals
2.5. Role of microbes in fixation and solubilization / mineralization of nutrients -- sulphur, nitrogen, phosphorus, carbon.

Unit III: Microorganisms and Diseases (12 hrs. approx.)

3.1. Human health and environment: MMR, IMR, Life expectancy, incidence of chronic diseases.
3.2. 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

3.3. Insect vectors of human diseases like Malaria, Dengue, Encephalitis, and their control.

3.4. Occupational diseases(Silicosis, Dermatitis and Asbestosis)

Unit IV: Applied microbiology (12 hrs. approx.)

4.1. Biocontrol of plant pathogens (general account)

4.2. Biodeterioration of materials

4.3. Basic techniques in genetic engineering: Plasmids and Gene cloning

4.4. Basic techniques in moleculear biology-PCR and electrophoretic technique

4.5. Antibiotics

4.6. Biosafety: introduction and guidelines.

BIBILIOGRAPHY

1. Microbiology: Eugene W. Nester; Nancy N. Pearsall; C. Evans Roberts; Martha T. Nester; Mary E. Lidstrom.
1. Microbes and Environment: A. B. Prasad and R.S. Biligrami.
2. Role of Microbes in the management of Environmental pollution: R. Tewari ; K.G. Mukerji ; J. K. Gupta ; L. K. Gupta.
3. Microbes and Man: John Postgate.
4. Microbiology- Basic principles and Application: Noel R. Rose: Alme L. Barron
5. Microbiology in patient care: Josephine A. Morello ; Helen Eckel Mizer ; Marion E. Wilson ; Paul A. Granate.
6. Environmental Microbiology: W. D. Grant; P. E. Long.
7. Microbial Technology: Rajni Gupta; K. G. Mukerji.
8. Microbial Ecology: Organisms, Habitats, Activities: Heinz Stolp.
9. Microbiology: J. Nicklin, K. Graeme- Cook and R. Killington.
10. Encyclopedia of Environmental Microbiology: P. Holter.
11. Food Microbiology: S. P. Narang.
12. Applied Microbiology Vol I Genetical & Biochemical applications; Neelima Rajvaidya ; Dilip Kumar Markandey.
13. Microbial processes – Promising Technologies for Developing Countries : National Academy of Sciences.
14. Microbiology – Fundamentals & Applications: S. S. Purohit.
15. Advances in Microbial Ecology: K. C. Marshall.
16. Preventive and Social Medicine: K. C. Park.
17. Environmental Education (Scientific, Social and Legal Aspects) : H. M. Dami.
18. Introduction to Microbiology: A.S. Roa.
19. Textbook of Microbiology: R. Ananthanaryan C. K. J. Paniker.
20. Textbook on food Contamination and Safety: Vanisha Nambiar.
21. Principles of Fruit Preservation: T. N. Morris.
22. Food Contamination – Origin, Propagation & Analysis: S. N. Mahinder.
23. Muir's Textbook of Pathology: J. R. Anderson.
24. Introductory Microbiology: Fredrick C. Ross.
25. The Microbial Challenge, Science, Disease & Public Health : Robrt I. Krasner
26. Applied Microbiology (Vol- 1-5) : Rajvaidye & Marhancley

27. Microbe & Man : John Postgate
28. Environmental Microbiology : Maier et.al.
29. Subsurface Microbiology & Biogeochemistry : Fredrickson & Fletcher
30. Microbial Culture (Introduction to Biotechniques) : Isaac & Jennings
31. Microbiology in Patient care : Morello et.al.
32. Food Contamination and Safety : Vanisho Nambiar

Paper 302: Environmental Laws

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: National & International Efforts (12 hrs. approx.)

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 and Earth summit)
1.4. CITES, 1973 and Biodiversity Act 2002
1.5. Espoo Convention, 1991
1.6. Indus Water Treaty, 1960

Unit II: National Laws- I (12 hrs. approx.)

2.1. Provisions of constitution (Article 21,48A, 51A, and 253)
2.2. Indian Forest Act, 1927; the Forest Conservation Act, 1980 and Rules, 1981.
2.3. Wildlife Protection Act, 1972 and amended 2002 and J & K Wildlife (Protection) Act 1978 as amended in 2002.
2.4. The Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975.
2.5. Air (Prevention and Control of Pollution) Act as amended by Amendment Act, 1987 and Rules 1982.
2.6. The Environmental (protection) Act, 1986 and Rules 1986.

Unit III: National Laws - II (12 hrs. approx.)

3.1. Hazardous Waste Management And Handling Rules, 1989
3.2. Biomedical Waste (management and handling) Rules, 1998.
3.3. Noise Pollution (Regulations and Control) Rules, 2000.
3.4. Municipal Solid Wastes (management and handling) Rules, 2000.
3.5. National Environment Tribunal Act, 1995.
3.6. National Green Tribunal Act, 2010

Unit IV: National Policy **(12 hrs. approx.)**

4.1. National Forest Policy 1988
4.2. Public Liability Insurance Act, 1991.
4.3. Patent Act - 2005.
4.4. Intellectual Property rights
4.5. Environmental related laws in J&K (Brief Description)

BIBILIOGRAPHY

1. Environmental Law & Policy in India: Diven Rosencranz.
2. Environmental Protection & the Law: R. K. Khitoliya.
3. International Environmental Laws: Priya Ranjan Trivedi.
4. Environmental Laws on Wildlife: P. R. Trivedi ; U. K. Singh.
5. Environmental law, the Economy and Sustainable Development: Revesz, Sands and Stewart.
6. Environmental Pollution and the Law: Justice V.R. Krishna Iyer.
7. Environmental Protection & Law: P. R. Trivedi and U. K. Singh.
8. Basic Laws of Environment: V. K. Prabhakar.
9. Management of Anti-Pollution Laws: Sukhpal Singh Rattan.
10. Environmental Protection and Law: V. K. Prabhakar.
11. Environmental Protection Law and Policy in India: Kailash Thakur.
12. Environmental Problems, Policies and Stategies: Jai Prakash; S. K. Srivastava.
13. Handbook of the convention on Biological Diversity: Earth Scan.
14. Environmental Law : Wolf and Stanley
15. Public interest litigation & Environmental Protection : Geetanjali Chandra
16. Environment and Legal Dimensions : Ahmad Hussain
17. Environmental Law : Dharmendra S. Sengar
18. Environmental Justice : C.M.Jariwala
19. Environmental Protection (Role of Space Law, Air Law) : S. Bhatt
20. Environmental Awareness & Protection : D.B.N Murthy

Paper 303: Environmental Impact Assessment

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: Environmental impact Analysis (12 hrs. approx.)

1.1. Environment impact assessment – concept, objectives, approaches and methods
1.2. Baseline data generation, requirement and planning of field survey
1.3. EIA Guidelines 2006 and amendments
1.4. National Resettlement and Rehabilitation policy, 2007
1.5. Protocol for Environment Impact Statements
1.6. Strategic Environmental Assessment and Cumulative Impact Assessment

Unit II: EIA Methodology (12 hrs. approx.)

2.1. Physical Environment Assessment
2.2. Flora Assessment
2.3. Fauna Assessment
2.4. Socio-economic surveys
2.5. Public participation in environmental decision making

Unit III: EIA Case Studies (12 hrs. approx.)

3.1. River Valley, Hydel, Drainage,Irrigation projects and concept of environmental flows
3.2. Industrial estates/ parks/ complexes/areas
3.3. Highways, railways, transport terminals
3.4. Thermal and Nuclear Power Projects
3.5. Cement and Chemical industries
3.6. Aerial ropeways

Unit IV: Environmental Auditing (12 hrs. approx.)

4.1. Principles and guidelines of Environmental Auditing
4.2. Preparation and submission of audit report to the regulatory bodies (as the MoE&F protocols)
4.3. Waste Audit Procedures – sources, types and management of wastes
4.4. ISO 9001 and 9002 and ISO 14000 series.

4.5. Ecomark

BIBILIOGRAPHY

1. Handbook of EIA: Judith Peth.
2. The Human Impact on the Natural Environment: Andrew Goudie.
3. Environmental Impact of Industries on Suburban Environment: S. .A. Abassi; S. Vinithan.
4. Environmental Problems Impact Assessment: P. .R Trivedi ; Gurdeep Raj.
5. Environmental Impact Assessment: A. K. Shrivastava.
6. The Theory and Practice of Environmental Impact Assessment: S. .A.. Abassi.
7. Environmental Impact of Industries on Sub-urban Environments: S. A. Abbasi; S. Vinuhan.
8. Ecological risk Assessment: Glen W. Sutter.
9. Environmental Impact Statement: Charles H. Eccleston.
10. Environmental Impact of Large Reservoir Projects on Human Settlement: A. K. Dalua.
11. Environmental Impact Assessment: Glasson; Therivel: Chadwick.
12. Environmental Impact assessment: V. K. Prabhakar.
13. Tourism management – The Socio-economic and Ecological Perspective: Tapan K. Panda; Sitikantha Mishra; Bivraj Bhushan Parida.
14. Sustainable Rural Development for Disaster Mitigation: Dr.Stendra (IFS); Prof. Vinod K. Sharma.
15. Environmental Planning for Rural development: Singh.
16. Tourism and the Environment: M. L. Narasiah.
17. Integrated Environmental Planning: James K. Lein.
18. Tourism Development: Principles and Practices. A. K. Bhatia.
19. Environmental Impact Assessment : A.K. Shrivastava
20. Handbook of Environmental Impact Assessment (Vol 1-2) : Judith Petts
21. Ecological Risk Assessment : Glenn W. Suter II
22. The Human Impact (Mans Role in Environmental Changes) : Andrew Goodie

Paper 304: Environmental Statistics, Computer Applications and Ecological Modeling

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: Biometrics (12 hrs. approx.)

1.1. Basic elements and tools of statistical analysis:
  - 1.1.1. Measurement of Central tendency – Mean, Mode and Median.
  - 1.1.2. Dispersion - mean deviation, standard deviation, standard error and coefficient of variation.
  - 1.1.3. Probability, Normal, Poisson and Binomial Distribution

1.2. Hypothesis Testing: Sampling and Test of Significance: Student's t- distribution, F distributions, Chi Square distribution,

1.3. Analysis of Variance: Post hoc tests in ANOVA: LSD, Tukey, Scheffe.

1.4. Non-parametric tests

1.5. Simple and multiple correlation and regression coefficients.

1.6. Cluster Analysis and Discriminant analysis, Principal component analysis, Factor analysis.

Unit II: Ecological Models (12 hrs. approx.)

2.1. Role of models in ecology.

2.2. Components of a model

2.3. Classes of mathematical models.

2.4. Models of population (growth and interaction) and pollutant dispersal.
  - a. Lotka – Volterra model
  - b. Leslie's matrix model
  - c. Gaussian plume model

2.5. Modeling of air quality, water quality and noise characteristics

Unit III: Basics of Computer (12 hrs. approx.)

3.1. Organization and working of a computer

3.2. Computer architecture fundamentals

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

3.4. Software: Windows operating systems
3.5. Important features of MS Word, MS Excel, and MS Power point

Unit IV: Information Technology (12 hrs. approx.)

4.1. Information and Communication technology: Advantages, disadvantages and uses
4.2. Information types, quality, needs; data processing - computer as a tool
4.3. Computer network and internet
4.4. Use of computer in ecological predictions and models
4.5. Data mining
4.6. Bioinformatics

BIBLIOGRAPHY

1. Biostatistical analysis: Jerrold H. Zar.
2. Biostatistics: S. P. Gupta.
3. Biostatistics and Biometrics: Satguru Prassad
4. Biostatistics: Arora Malhan.
5. Fundamentals of Ecology: E. P. Odum.
6. An Introduction to Statistical Methods: C. B. Gupta & Vijay Gupta.
7. Structured Computer organization: Andrew S. Tanenbaum.
8. IT Tools and Applications: Macmillan Publishers.
9. Internet 101, A Beginners Guide to the Internet and the Worldwide Web: Wendy G. Lehnert.
10. Fundamentals of Information Technology: Alexis Leon & Mathews leon.
11. Computer Networks: Fundamentals and Applications: R. S. Rajesh, K. S. Easwarakumar; R. Balasubramanian.
12. Computer Networks: A Systems Approach. Larry L. Peterson and Bruce S. Davie.
13. Mathematical Statistics with Applications: Miller and Miller.
14. Statistical Methods for Environmental and agricultural Sciences: A. Reza Hoshmand.
15. Introduction to Biostatistics and Research Methods : Rao & Richards
16. Statistical Methods for Environmental & Agricultural Science : A.Raza Hoshmand
17. Fundamentals of Environmental Discharge Modeling : Lorin R. davis
18. Advanced Ecological Theory (Principles & Application) : Jacqueline McGlade.
19. Mathematical Modeling of Biological Systems : Harvey J. Gold
20. Multivariate Statistics for the Environmental Sciences : Peter J.A.Shaw
21. Bioinformatics - A Modern Approach : Vittal R. Srinvas
22. Bioinformatics Methods and Application : Rastogi etal
23. Bioinformatics Computing: Bryan Bergeron

Laboratory Course ENS 311 **Third Semester**

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

Course Contents

1. Preparation of different microbial culture media.
2. Preparation of bacterial smears and gram staining.
3. Estimation of bacterial population in different water samples by culture technique.
4. Estimation of fungal population in different habitats through culture techniques.
5. Agarose gel electrophoresis technique
6. Antimicrobial sensitivity test
7. Biochemical test for different enzymes
8. Case studies based on environmental laws.
9. Survey of different residential areas for determining the prevalence of different air, water, soil and food borne diseases.
10. EIA – Leopold Matrix method and Case studies.
11. Case study on environmental auditing.
12. Demographic studies and population projection problems.
13. Socio-economic studies – preparing of questionnaire and Case studies.
14. Computation of standard deviation, standard error and coefficient of variation.
15. Computation of Correlation and Regression.
16. One way and two way classification of ANOVA.
17. Computation of Post hoc tests using statistical software
18. Designing of banner for World Environment Day using MS word
19. Implementation of mail merge- feature of MS word
20. Preparation of different pollution themes with the help of MS PowerPoint
21. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy

Note: At the end of Third Semester Students are required to undertake a field study trip to different climatic zones of the J & K State so as to acquire a thorough knowledge about the environmental problems facing the state. 25 marks are earmarked for the collection made during the trip and the report compiled by the student, which will form a part of Lab. Course 311. The Report (10 marks) and the Field Collection (15 marks) will be evaluated at the time of Practical Examination of the said Lab. Course.

FOURTH SEMESTER (2012)

The fourth semester will include four theory papers (ENS 401-404), laboratory course and dissertation (ENS 411) .The course contents of the four theory papers are given hereunder. The lab course will be based on the syllabi of the four theory courses.

Paper 401: Remote Sensing, GIS and Environmental Planning

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: Remote-sensing (12 hrs. approx.)

1.1. Basic principles of remote sensing
   a. Definition, scope and its role in environmental science
   b. Electromagnetic radiation (EMR) and electromagnetic spectrum
   c. Interaction of EMR with atmosphere
   d. Spectral reflectance of vegetation, soil and water
   e. Univariate and multivariate analysis

1.2. Satellite systems – IRS, Landsat and IKNOS

1.3. Aerial photography
   a. Definition and specifications for aerial photography
   b. Types of aerial photography
   c. Photogrammetry

Unit II: Geographic Information System (12 hrs. approx.)

2.1. Principles and scope of GIS, use of GIS. Data Models: Raster and Vector.

2.2. Raster and Vector GIS analysis

2.3. Map projections

2.4. Database concepts and types

2.5. Data quality standards

Unit III: Applications of Remote Sensing and GIS (12 hrs. approx.)

3.1. Role of RS and GIS in

a. Environmental Impact Assessment
b. Forest management
c. Watershed management
d. Monitoring of Biodiversity
e. Marine resources
f. Natural disaster management

Unit IV: Environmental Planning (12 hrs. approx.)

4.1. Environmental Planning – importance and objectives.
4.2. Land use planning.
4.3. Urban development and environmental Planning.
4.4. Rural development and environmental Planning.
4.5. Impact of Tourism on environment
4.6. Eco – Tourism – concept and importance.

BIBLIOGRAPHY

1. Environmental Auditing: A. K. Shrivastava.
2. Principles of Remote Sensing: A. N. Patel, Surrender Singh.
3. Remote Sensing and Image Interpretation: Lillesand and Kiefer.
4. Remote Sensing and Its Applications: Narayan.
5. GIS, Environmental Modelling and Engineering: Allan and Brimicombe.
6. Textbook of Environmental Remote Sensing: Sawmitra Mukherjee.
7. GIS Basics: Stephenwise.
8. George B. and Korte, P.E. The GIS Book
9. Remote sensing for environmental Science: Erwin Schander
10. Wetland and water resource modeling and assessment- A watershed perspective:Wei Ji:
11. Wetlands Monitoring Modeling and Management: Tomasz Okruszko, Edward Maltby, Ian Szatytowicz, Dorota Swiatek and Wiktor Kotowski
12. Remote sensing for wetland monitoring and waterfowl habitat management: Ketan Tatu, J.S.Parihar, M.M.Kimottu
13. Watershed and drainage : Drick Deep
14. Watershed management: Dr. Chandrawati Jee and Shagufta

402: Man and Environment

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: Environmentalism (12 hrs. approx.)

1.1. Environmentalism: concept and history
1.2. Environmental organizations (WWF, UNEP, IUCN, WHO) and conferences
1.3. Environmental movements in India – Narmada dam, Tehri dam, Almatti dam and Chipko
1.4. The monetization frontier
1.5. Environmental Politics

Unit II: Environmental Sociology (12 hrs. approx.)

2.1. Role of Agriculture in socio-economic development
2.2. Land reforms and Bhoodan Movement in India
2.3. Community development projects
2.4. Rural Social structure
2.5. Ecological theories of urbanisation
2.6. Urban social problems

Unit III: Environmental Education and Psychology (12 hrs. approx.)

3.1 Environmental education
3.2 Environmental Protection and religious teachings
3.3 Public awareness and role of NGOs
3.4 Environmental psychology and current problems
3.5 Environmental Ethics

Unit IV: Environmental Economics (12 hrs. approx.)

4.1. Environmental economics – Definition and Scope
4.2. Population, poverty and environment.
4.3. Concept of intangibles and externalities
4.4. Environmental evaluation methods: Hedonic pricing, Contingent evaluation and household production function.

4.5. Carbon credits and trading
4.6. Environmental Cost – Benefit analysis of developmental projects

BIBLIOGRAPHY

1. Environmental Awareness: I. Mohan.
2. Environmental Economics: M. V. Joshi.
3. Environmental Law, the Economy and Sustainable Development: Revesz, Sands and Stewart
4. Environmental Education: Desh Bandhu and G. S. Aulakh
5. Higher Education In India: Mehraj-ud-Din
6. Environmental Accounting and Reporting: Alok Kumar Pramanik
7. Eco-Informatics Green Management: S.K. Agarwal
8. Environmental Economics and Policy: Tietenberg
9. Issues in Environmental Economics: Hanley and Roberts
10. Environmental Education (Scientif, Social and Legal Aspects): H.M. Dani
11. Management of Environmental Education and Research: P.R.Trivedi and Gurdeep Raj
12. Environmental Economics: S.N. Prasad
13. Importance of Wildlife Conservation from Islamic Perspective: H.S.A. Yahya
14. Environmental Education: Ramesh Ghonta, Digumart and Bhaskara Rao
15. Environmental Education: Nasrin
16. Psychology: Jhon J. Seamon, Douglas and T. Kenrick
17. Rural Sociology: S.L. Doshi and P.C. Jain
18. Society in Focus – Introduction to Sociology: William E. Thompson and Joseph V. Hickey
19. Clinical Approach to Rural Development: E.D. Setty
20. Psychological Perspective in Environment and Development Issues: Abdesh Agarwal and A.K. Saxena.
21. Environmental psychology: Annete Bolger
22. Environmental psychology: A.K.Saran
23. Concepts in Environment: P.R.Trivedi and Gurdeep Raj
24. Environmental Science: Economic, Social and Political Dimensions: H.D.Kumar
25. Environment and Society: Francis Moore
26. Environmental Education: V.S.Sharma
27. Environmental pollution and education: P.P.Singh and Sandhir Sharma
28. Environmental Education: Dr. C.S.Patil and Prabhu M.Biradar
29. Environmental Economics-A Critical Overview: Alan Gilpin
30. Environmental Economics : R.Pushpakumari
31. The economics of the environment and natural resources: R.Quentin Graflon etal

Paper 403: Environmental Engineering

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: Basics of Environmental Engineering (12 hrs. approx.)

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

Unit II: Drinking Water Treatment (12 hrs. approx.)

2.1. Rainwater harvesting
2.2. Disinfection and Desalination of water
2.3. Methods of water purification: flocculation, sedimentation, sedimentation with coagulation
2.4. Filtration: sand filters, pressure filters, horizontal filters
2.5. Chemical treatment: Adsorption, Gas stripping, Ion exchange and distillation
2.6. Vector control measures – Drainage spraying; chemical and biological methods of vector eradication

Unit III: Sewage treatment (12 hrs. approx.)

3.1. Wastewater Treatment Plants: Concept, Methods and design
   a. Primary
   b. Secondary
   c. Tertiary
3.2. Sludge and its disposal techniques
3.3. Natural methods of sewage disposal
3.4. Reclamation and reuse of industrial and domestic wastewater.

Unit IV: Air and Soil Management (12 hrs. approx.)

4.1. Plume Rise and Design of Stack height
4.2. Bio-filters and control of air pollution

4.3. Hazardous waste management
   a. Transportation
   b. Treatment, storage and disposal
   c. Site remediation
4.4. Waste containment: land fills, slurry walls, drainage trenches and wells

BIBILIOGRAPHY

1. Basic Environmental Technology: Nathanson
2. Environmental Engineering: P. Venugopala Rao.
3. Elements of Environmental Engineering: Kalliat T. Valsaraj
4. Pollution Management: S.K. Agarwal
5. Handbook of Induastrial Pollution and Control: Bhatia
6. Fundamental of Water and wastewater: Krishna Gopal
7. Water Pollution Control: Helmer and Hespenhol
8. Advances in Wastewater Treatment Technologies: R.K. Trivedy
9. International Environmental Standards Handbook: Olson
10. Air Pollution: Godish
11. Environmental Air Pollution: D.Prasad and M.L. Choudary
12. Air Pollution and its Management: G. Gaur
13. Industries and Environment: Prabha Shastri Ranade
14. Environmental Engineering- a Design Approach: Arcardio P.Sincero and Gregoria A. Sincero
15. Environmental Engineering: D. Srinivasan
16. Waste water microbiology: Gabriel Bitton
17. Waste water and disposal: Paul T.Williams
18. Waste water management: Klein Gomes
19. Waste water treatment-concepts and design approach: G.L.Karia and R.A.Christian
20. Water and waste water technology: Merk.J.Hammer and Mark.J.Hammer Jr.
21. Biotechnology for water and waste water treatment: Dr.Satya Prakash
22. Biotreatment of agricultural waste water: Mark E.Huntely
23. Industrial waste water treatment: A.D.Patwardhan
24. Sustainable habitats in sustainable urban water management: Wagner, Marsalek and Breil
25. Phosphorus and nitrogen removal from municipal waste water –Principles and Practices: Richard Sedlak
26. Environmental water pollution and its control: G.R.Chhatwal, M.C.Mehra, M.Salake, T.Kalyal, Mohan Kalyal and T.Nagahiro
27. Air Pollution Control: S.P.Mahajan
28. Biofiltration for air pollution control: Joseph S.Devimny, Marc A.Deshusses and Todd S.Webster
29. Indoor air pollution characteristics, prediction and control: Richard A. Wadden and Peter A. Scheff

Paper 404 - Resource Management and Sustainable Development

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: Conservation Priorities (12 hrs. approx.)

1.1. Land resources: Conservation and Management
1.2. Forest conservation:
Social forestry and Joint forest management and rural eco-development
1.3. Energy crisis and Conservation of energy resources
1.4. Concept and strategies of sustainable development
1.5. Biodiversity Conservation
   a. In-situ conservation - National Parks, Sanctuaries, Biosphere Reserves, Ramsar Sites.
   a. Ex-situ conservation - Botanical gardens, Zoological parks, Zoos, Seed Banks, Agricultural Research Institutes.

Unit II: Management of Natural Resources (12 hrs. approx.)

2.1. Management of mineral resources through sustainable exploitation
2.2. Management of fresh water resources
2.3. Management of rangelands
2.4. Monitoring and management of bio-diversity
2.5. Concept of ecological footprint
2.6. Carbon sequestration

Unit III: Waste Management (12 hrs. approx.)

3.1. Sources and generation of solid wastes and their characteristics.
3.2. Methods of disposal of solid wastes.
3.3. Management of solid wastes.
3.4. Hospital waste management
3.5. Recycling of wastes for industrial, agricultural and domestic purposes.

Unit IV: Environmental Biotechnology (12 hrs. approx.)

4.1. Biotechnology

a. Concept and environmental relevance
b. Environmental risks

4.2. Biotechnology in Pollution control
4.3. Vermiculture technology
a. Earth worms and soil productivity
b. Earthworm culture and vermi-composting
4.4. Aquaculture Improvement through Biotechnology
4.5. Fish farming through biological wastes
4.6. Tissue culture – Concept, importance and methodology.
4.7. Agriculture Improvement through Biotechnology

BIBILIOGRAPHY

1. Forest Resources and Sustainable Development-Prnciples, Perspectives and Practices: Kailash Chandra Bebarta
2. Biodiversity Conservation in Managed Forests and Protected Areas: Kotwal and Banerjee
3. Biodiversity and Conservation: Michael J. Jeffries
4. Biodiversity: Supriyo Chakraborty
5. Environmental Concerns and Strategies: T.N. Khoshoo
6. Agricultural Microbiology: G. Rangaswami and D.J. Bagyaraj
7. Planning for Forest Resources and Biodiversity Management. Principles, rganisation and Methodologies: Kailash Chandra Beborta
8. Integrated Watershed Management: Rajesh Rajora
9. Environmental Biotechnology and Cleaner Bioprocesses: Eugenia J. Olguin, Gloria Sanchez, Elizabeth Hernandez
10. Biodiversity Endangered (India's Threatened Wildlife and Medicinal Plants): A.B. Chaudhuri and D.D. Sarkar.
11. Biotechnology in Environmental Management: T.K. Ghosh, T.K. Chakraborti, D.G. Tripathi
12. Vermiculture and Organic Farming : T.V. Sathe
13. Freshwater Aquaculture: R.K. Rath
14. Biodiversity Depletion: P.C. Sinha
15. Biodiversity Conservation: P.C. Trivedi and K.S. Sharma
16. Global Biodiversity Conservation Measures: T.I. Khan and Dhari N. AL-Ajmi
17. Environmental Protection and Sustainable Development: S. Bhatt
18. Natural Resources Conservation: V.K. Prabhakar
19. Biodiversity (Monitoring, Management, Conservation and enhancement): Ramamurthi Rallapalli and Geeta Bali
20. Environmental Biotechnology: S.N. Jogdand
21. Advances in Agricultural Microbiology: Subba Rao
22. Pollution – Ecology and Biotreatment: Mc Eldowney and Waile
23. Aquaculture, Principles and Practices: T.V.R. Pillay
24. Ponds and Fishculture: C.B. Hall
25. An introduction to plant tissue culture: Razdan
26. Methods in plant tissue culture: Kumar and Kumar
27. Plant Biotechnology and Tissue Culture, Principles and Perspectives: Atul Kumar and V.A. Kumar

28. Trends in Plant Tissue Culture and Biotechnology: Pareek
29. Plant Tissue Culture: A.S. Islam
30. Environmental Issues and Sustainable Development: S.C. Kalwar
31. Aquaculture and Fisheries Biotechnology – Genetic Approaches: R.A. Dunham
32. Environmental conservation and development: B.P.Pal
33. Environmental management- basic and applied aspects of management of ecological and environmental system: Dr. Biswarup Mukherjee
34. Environmental management: P.S.Aradhana
35. Environmental management in India: R.K.Sapru
36. Biodiversity: Dr. Janamjit Singh
37. Conservation of faunal diversity in forested landscapes: R.M.Degraff and D.I.Miller
38. Bioresources and gene pool conservation: M.P.Singh and Soma Dey
39. Managing our natural resources: William G.Camp and Thomas B.Daughterly
40. Natural resource conservation and environment management: Ashish Ghosh
41. Green technologies for environmental management and sustainable development: Rajiv K.Sinha and Maragret Greenway
42. Environmental conservation and planning: Rajendra Menaria
43. Environmental waste management: J.P.Shastri
44. Management of pollution control: P.R.Trivedi and Gurdeep Raj
45. Industrial wastes-their disposal and treatment: Willem Rudolfs
46. Solid waste management in Indian cities-status and emerging practices: Darshini Mahadevia and Jeanne M.Wolfe
47. Solid Waste Management: Surinder Kumar
48. Wildlife ecology, conservation and management: Anthony R.E.Sinclair, John M. Fryell and Graeme Caughley
49. Soil science management: Edward J.Plaster
50. Environmental biotechnology and cleaner bioprocesses: Eugenia J.Olgium, Gloria Sanchez and Elizabeth Hernandez
51. Vermisource technology: G.Tripathi
52. Environmental biotechnology-theory and application: Gareth M.Evans and Judith C.Furlong

Laboratory course and Dissertation ENS -411

a. Laboratory Course (Fourth Semester)

Marks: 50 (Internal Assessment 10 + Terminal Exam 40) Time 5hrs.

Course Contents

1. Visual interpretation of satellite data
2. Land use / land cover classification from satellite data
3. Calculation of slope and aspect
4. Delineation of drainage of a given area from satellite data.
5. Delineation of point, line and polygon themes
6. Calculation of area using Planimeter / grid method.
7. Preparation of thematic maps using R. S. maps.
8. Working and design of Treatment plants.
9. Observations on plant and animal growth using waste water.
10. Study of effect of wastewater - treatment on seed germination.
11. Determination of colonization potential of macroinvertebrates in different aquatic ecosystems on artificial substrates
12. Determination of colonization potential of periphyton in different aquatic ecosystems on artificial substrates
13. Media preparation for in-vitro growth of explants
14. Inoculation and incubation of explants
15. Study of morphogenetic response of explants on media

b. Dissertation

The dissertation will carry 150 marks (90 for the evaluation of the dissertation, 30 each for Viva Voce and Internal Assessment) and will be based on the dissertation work on the projects allotted to the student during the first semester of the course. The projects will be allotted by the concerned Head of the Department in consultation with the faculty members and the list of the topics allotted will be communicated to the Chairperson of the Board of Post Graduate studies in Environmental Science for record and necessary action. The student will have to submit the dissertation at the end of the fourth semester before the theory examination. The dissertation will be evaluated by the external examiner appointed by the University for the purpose. The Viva Voce test will be conducted by the concerned Head of the Department and the External Examiner.