ಮಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

MANGALORE UNIVERSITY

{Accredited by NAAC with 'A' Grade)

ಕುಲಸಚಿವರ ಕಚೇರಿ
ಮಂಗಳಗಂಗೋತ್ರಿ – 574 199
ಕರ್ನಾಟಕ, ಇಂಡಿಯ

Office of the Registrar
Mangalagangothri - 574 199
India

ಕ್ರಮಾಂಕ//No. MU/ACC/CR6/CBCS-PG(SLB)/2017-18/A2

ದಿನಾಂಕ/Date : 8/5/2017

N O T I F I C A T I O N

Sub: I, II, III & lV semester Choice Based Credit System syllabus of M.Sc. in Environmental Science degree programme.

Ref: 1) This office Notification No. MU/ACC/CR7/CBCS-PG(SLB)/ 2016-17/A2, dated: 17-8-2016.
2) Academic Council decision dated 3-2-2017 vide Agenda No. 3:11 (2016-17)

In continuation to this office Notification cited under ref. (1) above, the syllabus of I, II, III & IV semester M.Sc. in Environmental Science degree programme which approved by the Academic Council at meeting held on 3-2-2017 is hereby notified for implementation with effect from the academic year 2017-18 and onwards (for students of 2016-17 batch and onwards).

REGISTRAR

To:

1) The Chairman of the Department concerned/ The Coordinator of the degree programme concerned.
2) The Principal of the college concerned.
3) The Registrar [Evaluation], Mangalore University.
4) The Chairman of the Board of Studies concerned.
5) The Superintendent [ACCJ, Office of the Registrar, Mangalore University.
6) Guard file.

MANGALORE UNIVERSITY

DEPARTMENT OF BIOSCIENCES

SYLLABUS AND SCHEME OF EXAMINATIONS FOR TWO YEAR (FOUR SEMESTERS) M.Sc. DEGREE PROGRAMME IN ENVIRONMENTAL SCIENCE UNDER CHOICE BASED CREDIT SYSTEM (CBCS – 2016)

Preamble:

The University Grants Commission, New Delhi has directed all Universities in the Country to implement the Choice Based Credit System (CBCS Semester Scheme) in both the Undergraduate and Post-Graduate Programmes. The Higher Education Council, Government of Karnataka also considered the implementation of CBCS. Mangalore University has directed all the P.G. Board of Studies to frame the new syllabus for the P.G. Programmes as per the new regulations governing the Choice Based Credit System for the Two Year (Four Semester) Post –Graduate Programmes. The Registrar, Mangalore University has sent a letter No.: MU/ACC/CR.38/CBCS(PG)/2015-16/A2 dated 05.05.2016 to the PG BOS in Biosciences and asked the B.O.S to prepare syllabus for M.Sc. Environmental Science Programme. Accordingly the internal members of P.G. Board of Studies in Biosciences prepared draft syllabus. The syllabus is placed before the P.G. Board of Studies. The P.G. Board of Studies in Biosciences thoroughly discussed, modified and finalized the draft syllabus.

The present M.Sc. Programme (Environmental Science) under CBCS – PG Scheme has total credits 88 (Hard Core credits: 52 (59.09%), Soft Core credits: 30 (34.09%) and Open Elective credits: 06 (6.97%))

M.Sc. ENVIRONMENTAL SCIENCE
PROGRAMME CONTENTS

	Hrs/week	Credits
I SEMESTER		
HARD CORE COURSES - THEORY		
ESH401 Ecology and Biodiversity	4	4
ESH402 Environmental Meteorology and Geography	4	4
ESH403 Biological Chemistry	4	4
SOFT CORE COURSES - THEORY (Out of 2 Courses ONE to be offered)		
ESS404 Environmental Geology	3	3
ESS405 Environmental Microbiology	3	3
PRACTICAL COURSES		
ESP406 Ecology and Biodiversity Lab	4	2
ESP407 Environmental Meteorology and Geography Lab	4	2
ESP408 Biological Chemistry Lab	4	2
ESP409 Environmental Geology Lab	4	2
ESP410 Environmental Microbiology Lab	4	2
II SEMESTER		
HARD CORE COURSES - THEORY		
ESH451 Socio-Economic aspects of Environment	4	4
ESH452 Environmental Pollution	4	4
SOFT CORE COURSES - THEORY (Out of 3 Courses TWO to be offered)		
ESS453 Environmental Chemistry	3	3
ESS454 Analytical and Statistical Methods	3	3
ESS455 Environmental Health Management	3	3
PRACTICAL COURSES		
ESP456 Socio-Economic aspects of Environment Lab	4	2
ESP457 Environmental Pollution Lab	4	2
ESP458 Environmental Chemistry Lab	4	2
ESP459 Analytical and Statistical Methods Lab	4	2
ESP460 Environmental Health Management Lab	4	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)		
ESE461 Basic science concept in Environment	3	3
ESE462 Environmental Education and Legislations	3	3

III SEMESTER

HARD CORE COURSES - THEORY

ESH501 Environmental Pollution Abatement	4	4
ESH502 Environmental Protection	4	4

SOFT CORE COURSES - THEORY (Out of 3 Courses TWO to be offered)

ESS503	Environmental Impact Assessment	3	3
ESS504	Environmental Management Tools	3	3
ESS505	Human Population and Environment	3	3

PRACTICAL COURSES

ESP506 Environmental Pollution Abatement Lab	4	2
ESP507 Environmental Protection Lab	4	2
ESP508 Environmental Impact Assessment Lab	4	2
ESP509 Environmental Management Tools Lab	4	2
ESP510 Human Population and Environment Lab	4	2

OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)

ESE511 Natural Resources	3	3
ESE512 Waste Management	3	3

IV SEMESTER

HARD CORE COURSES - THEORY

ESH551 Environmental Biotechnology	4	4

SOFT CORE COURSES - THEORY (Out of 2 Courses ONE to be offered)

ESS552 Environmental conservation and management	3	3
ESS553 Environmental Toxicology	3	3

PRACTICAL COURSES

ESP554 Environmental Biotechnology Lab	4	2
ESP555 Environmental conservation and management Lab	4	2
ESP556 Environmental Toxicology Lab	4	2

PROJECT WORK

ESP557 Project Work (Dissertation and Viva)	4	4

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M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

(CBCS Semester Scheme)

Scheme of Teaching and Examination

(As per the University Guidelines)

2016-17

I SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH401	Ecology and Biodiversity	4	3	70	30	100	4
ESH402	Environmental Meteorology and Geography	4	3	70	30	100	4
ESH403	Biological Chemistry	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 2 Courses ONE to be offered)							
ESS404	Environmental Geology	3	3	70	30	100	3
ESS405	Environmental Microbiology	3	3	70	30		
PRACTICAL COURSES							
ESP406	Ecology and Biodiversity Lab	4	3	70	30	100	2
ESP407	Environmental Meteorology and Geography Lab	4	3	70	30	100	2
ESP408	Biological Chemistry Lab	4	3	70	30	100	2
ESP409	Environmental Geology Lab	4	3	70	30	100	2
ESP410	Environmental Microbiology Lab	4	3	70	30		
Total						**800**	**23**

II SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH451	Socio-Economic aspects of Environment	4	3	70	30	100	4
ESH452	Environmental Pollution	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 3 Courses TWO to be offered)							
ESS453	Environmental Chemistry	3	3	70	30	100	3
ESS454	Analytical and Statistical Methods	3	3	70	30		
ESS455	Environmental Health Management	3	3	70	30	100	3
PRACTICAL COURSES							
ESP456	Socio-Economic aspects of Environment Lab	4	3	70	30	100	2
ESP457	Environmental Pollution Lab	4	3	70	30	100	2
ESP458	Environmental Chemistry Lab	4	3	70	30	100	2
ESP459	Analytical and Statistical Methods Lab	4	3	70	30	100	2
ESP460	Environmental Health Management Lab	4	3	70	30		
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
ESE461	Basic science concept in Environment	3	3	70	30	100	3
ESE462	Environmental Education and Legislations	3	3	70	30		
Total						**900**	**25**

III SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH501	Environmental Pollution Abatement	4	3	70	30	100	4
ESH502	Environmental Protection	4	3	70	30	100	4
SOFT CORE COURSES – THEORY(Out of 3 Courses TWO to be offered)							
ESS503	Environmental Impact Assessment	3	3	70	30	100	3
ESS504	Environmental Management Tools	3	3	70	30	100	3
ESS505	Human Population and Environment	3	3	70	30		
PRACTICAL COURSES							
ESP506	Environmental Pollution Abatement Lab	4	3	70	30	100	2
ESP507	Environmental Protection Lab	4	3	70	30	100	2
ESP508	Environmental Impact Assessment Lab	4	3	70	30	100	2
ESP509	Environmental Management Tools Lab	4	3	70	30	100	2
ESP510	Human Population and Environment Lab	4	3	70	30		
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
ESE511	Natural Resources	3	3	70	30	100	3
ESE512	Waste Management	3	3	70	30		
Total						**900**	**25**

IV SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH551	Environmental Biotechnology	4	3	70	30	100	4
SOFT CORE COURSES - THEORY(Out of 2 Courses ONE to be offered)							
ESS552	Environmental conservation and management	3	3	70	30	100	3
ESS553	Environmental Toxicology	3	3	70	30		
PRACTICAL COURSES							
ESP554	Environmental Biotechnology Lab	4	3	70	30	100	2
ESP555	Environmental conservation and management Lab	4	3	70	30	100	2
ESP556	Environmental Toxicology Lab	4	3	70	30		
PROJECT WORK							
ESP557	Project Work (Report/Dissertation)			70	30	100	4
Total						**500**	**15**
Grand Total						**3100**	**82+6***

IA = Internal Assessment
***** Not included for CGPA

Total Credits: 88 (82+6*)
Hard Core credit: 18 + 12 +12+10 = 52 (59.09%)
Soft Core credit: 05 + 10 + 10 +05 = 30 (34.09%)
Open Elective credit: 0 + 03 + 03 + 0 = 06 (6.97%)

NOTE:

BASIS FOR INTERNAL ASSESSMENT: Internal Assessment marks in theory papers shall be awarded on the basis of theory test (70 Marks), Objective Test (MCQs)(15 Marks), Seminars and Assignments (15 Marks). The marks obtained shall be reduced to 30. The tests may be conducted 14 weeks after the start of a Semester. Practical Internal Assessment marks shall be based on practical test and records. 60 marks for Practical test and 10 marks for Class record. The marks obtained shall be reduced to 30. The test may be conducted 14 weeks after the start of a Semester. 30 marks for project work (Report/Dissertation and Presentation/Viva).

THEORY QUESTION PAPER PATTERN: Question Papers in all the four semesters consists of three sections (Model question paper enclosed). Section I: Write short notes on any four out of six: (4x4=16 Marks) Section II: Write explanatory notes on any five out of seven: (5x6=30 Marks). Section III: Answer any two out of three: (2x12=24 Marks). Questions are to be drawn from all the units of the syllabus by giving equal weightage to all the units.

PRACTICAL QUESTION PAPER PATTERN: 60 marks for practical exam proper (Major experiment-20 marks, Minor experiments- 10+10 marks, Identify and Comment on-5x4=20marks) and 10 marks for Class record. The Project work may be conducted either in the department or any other Institution or in an Industry. Project Report/Dissertation carries 70 marks and evaluated as per regulations.

Model Question Paper

First Semester M.Sc. Degree Theory Examination, December 2016

(CBCS)

ENVIRONMENTAL SCIENCE

ES

Time: 3 Hours Max. Marks: 70

Write short notes on **any four** of the following (not exceeding **2** pages **each**): **(4x4=16)**

1. a)
   b)
   c)
   d)
   e)
   f)

Write explanatory notes on **any five** of the following (not exceeding **3** pages **each**): (**5x6=30)**

2.
3.
4.
5.
6.
7.
8.

Answer **any two** of the following (not exceeding **8** pages **each**): **(2x12=24)**

9.
10.
11.

M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

(CBCS Semester Scheme) 2016-17

SYLLABUS

I SEMESTER

HARD CORE PAPERS

ESH401 ECOLOGY AND BIODIVERSITY

UNIT I (13 hours)

Concepts of ecosystem: History, definition and characters, biotic and abiotic components of ecosystem. Energy flow, energetics, ecological efficiency, trophic relationships, food webs, productivity and carrying capacity.

UNIT II (13 hours)

Population Ecology: Growth, mortality, natality, population fluctuations, population interactions, host-parasite interaction. Population characters and demography.

Community ecology: Community structure, characters, types of communities - terrestrial, forest, grassland, dry land, deserts, wetland and aquatic - lakes, rivers, oceans.

UNIT III (13 hours)

Basics of biodiversity: Patterns of living organsims – classification and evolution; characterizing species, basics of taxonomic characterization, magnitude and distribution of biodiversity, speciation, ecology of extinction.

UNIT IV (13 hours)

Biodiversity and Bioresources: Types of Biodiversity - species diversity, ecosystem diversity, genetic diversity; biodiversity and ecology, Bioresources - terrestrial, aquatic, agricultural and forest resources.

References:

1. Clarke, G.L., 1974. Elements of Ecology, John Wiley & Sons, New York.
2. Brock, T.D. & Madigan, M.T., 1986. Biology of microorganisms; Prentice Hall, New Jersy.
3. Dadhick, L.K., 2002. Biodiversity. Strategies for Conservation. APH Publishers, New Delhi.
4. Agarwal, S.K., 2002. Biodiversity and Environment, APH Publishers, New Delhi.
5. Nagore, A.P., 2000. Biological Diversity and International Environment Law.
6. George, A., 2000. The Ecology of sea shores. CRC Press.
7. Mukerji, K.G., 1997. Red Algae, Structure, Ultrastructure and Reproduction.
8. Ashuthosh Gautham, Aquatic Environment.
9. Keddy, P.K., 2000. Wetland Ecology, Cambridge University Press.
10. Chatrath, K.J.S., Wetlands of India.
11. Mahajan, S.E., 1999. Industrial Ecology. Lewis Publishers.
12. Ambasht, R.S., 2002. Modern Trends in Ecology and Environment.

13. Lambers, H., 2002. Plant Physiological Ecology.
14. Arjun Prasad Nagore, 1996. Biological Diversity and International Environmental Law
15. Odum, E.P., 1971. Fundamentals of ecology.
16. Barbour M.D., 1980.Terrestrial Plant Ecology. The Benjamin Cummings Publication Co., California.
17. Furley, P.A. Newey , W.W., Kirby R.P. and Hoston, J Nc. G., 1983. Geography of the Biosphere - An Introduction to the Nature, Distribution and Evolution of the World's Life Zones.

ESH402 ENVIRONMENTAL METEOROLOGY AND GEOGRAPHY

UNIT I (13 hours)

Earth as a planet: Motions of the earth, seasons. Laws of thermodynamics: concept of fluid mechanics. Thermal balance: Heat production and loss, sea-surface interaction. SST, heat islands, electromagnetic spectra: solar radiation, photochemical and photosensitized reactions.

UNIT II (13 hours)

Radioactivity: Origin of radio nuclei, natural and artificial; their effects on the ecosystem; biological effect of radiation. Concepts of residence time of moisture and gaseous components.

UNIT III (13 hours)

Geographical concepts related to environment: economic geography, agro – climatic regions, industry and environment. Energy sources and consumption patterns in urban and rural areas. Climatology: Elements and factors of climate, climatic control, climate change, continental influence on climate, urban and rural climate; artificial climates, climate policy.

UNIT IV (13 hours)

Interpretation of Weather satellite images, surface temperature measurement, cloud top height determination, rain rate and wind velocity measurement and weather prediction,
Use of microcomputers in instrumentation and in measurement systems.

References

1. Arya, S.P., 2002. Introduction to Micrometeorology 2nd Ed.
2. Bailey R.G., 2002. Ecosystem Geography
3. Beven, K., 2002. Rainfall-Runoff Modeling: The Primer.
4. Ketan Tatu, 1999. Remote sensing for Wetland monitoring & Waterfowl Habitat Management.
5. Frew, J., 1986. Geography fieldwork, Macmillan.
6. Gardiner, V. & Dackombe, R.V., 1983. Geomorphological field manual. Allen & Unwin.

7. Gilbertson, D.D., Kent, M. & Pyatt, K.B., 1985. Practical ecology for Geography and Biology: Survey, Mapping and Data Analysis. Hutchinson.
8. Goudie, A. (ed.), 1990. Geomorphological techniques. Unwin Hyman.
9. Haines – Young, R.H & Petch, J.R., 1986. Physical Geography: its nature and methods. Harper.
10. Jones, A.P., Tucker M.E. & Hart, J.K., 1999. Description and analysis of Quaternary stratigraphic field sections. Quaternary Research Association Technical Guide 7. QRA.
11. Lal, R., 1994. Soil erosion research methods, 2nd ed. Ankeny: SWCS.
12. Matthews, H.M. & Foster, I.D., 1986. Field work exercises in human and physical geography, Arnold.
13. Parsons, T. & Knight, P.G., 1995. How to do your dissertation in geography and related disciplines. Chapman & Hall.
14. Ritchie, W., Wood, M., Wright, & Tait, D., 1988. Surveying and mapping for field scientists. Longman.
15. Rogers, A., Viles, H. & Goudie, A., 1992. The student's companion to Geography. Blackwell
16. Tucker, M., 1988. Techniques in sedimentology. Blackwell.

ESH403 BIOLOGICAL CHEMISTRY

UNIT I (13 hours)

Basic concepts: Introduction to bimoleculas, classification, type; bonding in biomolecules. Structure of water - hydrophobic, hydrophilic interactions in biological systems.

UNIT II (13 hours)

Proteins; Amino acids and peptides – classification and structure and functions; synthetic polypeptides. Enzymes and coenzymes – classification structure and functions.

Nucleic acids: Elementary concepts of nucleosides, nucleotides and polynucleotides. Structure and functions of DNA and RNA.

UNIT III (13 hours)

Lipids: common classes of lipids – glycerolipids, phospholiods and sphingolipids structure and properties.

Carbohydrates: Monosaccharides, oligosaccharides and polysaccharides. Structure and functions of some important polysaccharides (starch, cellulose, glycogen, heparin, chitin, pectins, hemicellulose and chondroin).

UNIT IV (13 hours)

Membranes : Biomembrane organisation – membrane lipids, membrane bound proteins. Properties of membranes and transport mechanism. Metabolism and bioenergetics. Overview of metabolism - catabolic and anabolic process, glycolysis, citric acid cycle and oxidative phosphorylation.

References

1. Vogel, A.L., 1971. Elementary practical organic chemistry. Vol. 3 Quantitative organic analysis. Langman ELBS.
2. Frieser, L.F. 1968. Organic chemistry experiments. (D.C. Health & Co.).
3. Elmose, D.T., 1968, Peptides and proteins. Cambridge University Press.
4. Finer, L.L. 1980. Organic chemistry. Vol. I & II. Lynem (ELBS).
5. Morison, R.T., and Boyd, R.N., 1983. Organic Chemistry. McGraq Hill. Kogakusha.
6. Pigman & Horton, D., 1970. The carbohydrates. Chemistry and biochemistry, 2nd ed. Vol. IA & IB. Plenum Press, New York & London.
7. Branden, C. and Tooze, J. 1991. Introduction to Protein Structure. Garland Publishing Inc.
8. Cantor and Schimmel, 1980. Biophysical Chemistry Part I & III, WH Freeman and Co.
9. Dickerson and Geis, 1969. The structure and action of proteins. Benjamin/ Cummings Publishing.
10. Jayaraman, J., 1948. Laboratory Manual of Biochemistry.

SOFT CORE COURSES

ESS404 ENVIRONMENTAL GEOLOGY

UNIT I (13 hours)

Introduction to Environmental Geology: Components of physical environments, geospheres - atmosphere, hydrosphere, lithosphere and biosphere.

Seismology and structure of earth: Mineralogy, seismic and tectonic processes, soil formation and its conservation; biogeochemical cycles.

UNIT II (13 hours)

Geomorphology: Weathering and erosion, slopes, valleys, streams, springs, lakes, landscapes and environmental aspects of reservoir siltation; river networks; natural hazards – earthquakes, landslides and volcanoes.

Basic aspects of paleontology: Geological time scale, ice age, geology of ocean floor, waves, tides and currents and shore line processes; environmental aspects of coastal zones; sea level rise and siltation.

UNIT III (13 hours)

Ground water - origin movement and storage of ground water, factors, controlling storage and movement; wells - permanent and artisan; springs and factors controlling their location tanks - major and minor and their siltation.

References

1. Allen, J.R.L., 1977. Physical Processes of contamination. George Allen & Unwin.
2. Bateman: Economic Mineral deposits

3. Billings, M.P., Destller, L.U., 1972. Structural Geology, Prentice Hall
4. David Kieth Todd, 1980. Ground water Hydrology, II Ed. John Wiley & Sons.
5. Davis, R.A Jr. 1985. Coastal sedimentary Environments.
6. Deer Howie and Zummann, 1977. Rock forming minerals. ELBS & Longmann.
7. Garlans, G.D., 1971. Introduction to Geophysics. Toppen Publ. Co., Tokyo.
8. Hughes, C.J., 1982. Igneous Petrology
9. Lehee, F.H. 1961. Field Geology, McGraw
10. Mason, B., 1958. Principles of Geochemistry
11. Open University Series, 1982. Earth Dynamics, Open University Press.
12. Pettijonn, F.J., 1975. Sedimentary rocks
13. Rose, D.A. Introduction to Oceanography.
14. Winker, H.G.F., 1988. Petrogenesis of Metamorphic Rocks. McGraw Hill Publishers.
15. Wyllie, P.J., 1971. The dynamic earth. A text book in Geoscience, John Willem & Sons.

ESS405 ENVIRONMENTAL MICROBIOLOGY

UNIT I (13 hours)

Introduction to microbiology, historical perspectives, branches and scope of microbiology. Microbial growth, population and growth curves, sterilization and culturing techniques, factors affecting growth and death of microorganisms: temperature, pH, water activity, O-R potential, salinity, hydrostatic pressure, disinfectants, antiseptics and chemotherapeutic agents.

UNIT II (13 hours)

Microbial Ecology: Microbial symbiosis, mutualism, plant-microbe interactions (e.g. mycorrhizas), animal-microbe interactions (human, ruminants and non-ruminants). Microbes in hydrothermal vents and coral reefs.

Aquatic Microbiology: Microbes in water and methods of their estimation (e.g. MPN), drinking water standards, water-borne diseases and prevention.

UNIT III (13 hours)

Soil Microbiology: Soil microflora and methods of their estimation, role of soil microorganisms in bioconversion and decomposition. Biological nitrogen fixation (symbiotic and non-symbiotic), microbial phosphorus solubilization and their importance in soil fertility and agriculture.

Air Microbiology: Microflora of air and methods of their estimation, air-borne diseases and prevention.

References:

1. Brock, T.B. and Madigon, M.T., Biology of microorganisms, Prentice Hall.
2. Pelczar, J. and Chan, E.C.S., Element of Microbiology, Mac Graw Hill New York.

3. Schlegel, H.G., General Microbiology, Cambridge Univ. Press.
4. Rosenberg, E. and Cohen I.R., Microbial Biology, Saunders Coll. Publ.
5. Stanier, R.Y. *et al*., The Microbial World, Prentice Hall, New Delhi.
6. Atlas, R.M. and Bartha R. Benjamin, Microbial Ecology, Cummings Sci. Press, USA.
7. Cruickshank, R., Medical Microbiology. Churchill Livingstone, London.
8. Doelle, H.W., Bacterial Metabolism. Academic Press, London.
9. Nickilin *et al.*, Instant Notes in Microbiology, Via Books Pvt. Ltd., New Delhi.
10. Norris, J.R., Methods in Microbiology. Academic Press, London.
11. Adams, M.R. and Moss, M.O., Food Microbiology, Panima Publ., New Delhi.
12. Barrett, J.T., Microbiology and Immunology Concepts, Lippincott-Raven, USA.
13. Casida, L.E., Industrial Microbiology, Wiley Eastern Ltd., New Delhi.
14. Elgert, KD., Immunology, Jon Wiley and Sons, USA.
15. Subba Rao, N.S., Advances in Agricultural Microbiology, Oxford and IBH Publ., New Delhi.
16. Alexopoulous, G.J., Introductory Mycology, Wiley Eastern Limited., New Delhi.
17. Cambell, R., Microbial Ecology. Blackwell Scientific Publ., London.
18. Webster, J., Introduction to Fungi. Cambridge University Press, Cambridge.

PRACTICAL COURSES

ESP406 ECOLOGY & BIODIVERSITY LAB

1. Microscopic observations of microbes - Keys to identify microorganisms.
2. Practical exercises in identification of symbiotic organisms.
3. Study of aquatic communities – Aquatic plants and animals.
4. Study of intertidal organisms.
5. Study of mangrove vegetation.
6. Study of seaweeds.
7. Identification of bryophytes, ferns and higher plants.

ESP407 ENVIRONMENTAL METEOROLOGY AND GEOGRAPHY LAB

1. Weather data analysis (image analysis).
2. Generation of data bases - G.S. handling, scanning and digitization.
3. Exercises related to earth projections.
4. Exercises related to potential evapotranspiration.
5. Practicals related to human settlement analysis.
6. Agricultural yield estimation using satellite data.
7. Practicals on diseases of crop plants by insect.

ESP408 BIOLOGICAL CHEMISTRY LAB

1. Determination of amines and amino acids.
2. Determination of carbohydrates.
3. Qualitative tests for the identification of monosaccharides, disaccharides and polysaccharides.
4. Qualitative tests for proteins, lipids and NPN substances.
5. Precipitation reactions of proteins.
6. Spectrophotometric estimation of serum protein, blood sugar, urine creatinine, blood urea, plant phenolics and ascorbic acid.

ESP409 ENVIRONMENTAL GEOLOGY LAB

1. Study of minerals – Hand Specimens
2. Study of Rocks – Hand Specimens
3. Structural Geology – Interpretation of geological maps, solving Dip and Strike Problems
4. Sedimentology – Classification of sediments, sediment and rock fragments.
5. Sieve analysis of sediments, pipette analysis, pebble classification
6. Study of littoral drift in the field and laboratory using dye and tracer techniques
7. Drainage Basin Analysis Generation to drainage density and drainage frequency maps
8. Exercises related to water budget
9. Exercises related to Potential Evapotranspiration
10. Compute monthly water budget from the given data
11. Ground water quality – Impact and Testing.
12. Interpretation of waves, climate, tides and currents for the given data

ESP410 ENVIRONMENTAL MICROBIOLOGY LAB

1. Introduction to basic techniques and instrumentation in microbiology.
2. Simple and differential staining for morphological studies.
3. Assessment of microflora of soil, water and air.
4. Isolation of microbes using selective media.
5. Studies on symbiotic association of microorganisms.
6. Assessment of microbial quality of drinking water and milk.
7. Microbiological assays.

II SEMESTER
HARD CORE COURSES

ESH451 SOCIO-ECONOMIC ASPECTS OF ENVIRONMENT

UNIT I (13 hours)

Introduction to cultural, social, geographical and economical anthropology. Eugenics and euthenics. Rehabilitation of human population. Social and cultural differences in the perception of values of resources.

Sociology of development, common property resources, environmental movements: Role of women in environment, tribes and environment, cost of environmental protection.

UNIT II (13 hours)

Environment and sustainable development: Measuring of sustainable development, global awareness, global and national environmental issues, manpower and training programmes.

UNIT III (13 hours)

Nature and scope of environmental economics: economic planning and development related to environment; planning, decision and implementation processes; cost benefit analysis of environment, common property rights. Market for environment, valuing environment and natural resources.

UNIT IV (13 hours)

Socio-economic dimensions of environment: Sustainable development Vs environmental development; Use and non-use value of resources; valuation, risk and uncertainty of resources; share of benefits of resources; environmental values, ethics and equity. Measurement environmental degradation.

References

1. Dasgupta, P. and Heal, G.M. 1998. Economic Theory of Exhaustible Resources, Oxford University Press, New Delhi.
2. Hantey, N., 1996. Environmental Economics - Theory and Practice, Manasa Publication, New Delhi.
3. Kalpagam, M., 1992 Environmental Economics - A Textbook. Sterling, New Delh.
4. Kolstad, C.D., 1999. Environmental Economics. Oxford University Press, New Delhi.
5. Thabeeb, K., 1996. Environment Protection Law and Policy in India. Deep and Deep, New Delhi.
6. Pearce, D.W. and Turner, R.K. 1990. Economics of Natural Resources and Management, Harvester, New York.
7. Juan Martinez-Alied, 1987. Economics, Energy and Environment. Basil Blackwell.
8. Slebeht, H., 1992. Economics of Environment – Theory and Policy, Springer Verlag.
9. Hines, L.G., 1988. The Market, Energy and Environment, Allyn and Bacon, Boston.

10. Trivedi, P.R. (ed.) 1994. Sustainable Development - Global Perspective, Commonwealth, New Delhi.
11. Bermann, P. (Ed), 1995. Health sector reforms in developing countries, Marking health development sustainable, Harward University Press.
12. Sengupta, R.P., 2001. Ecology and Economics: An approach to sustainable development, Oxford University Press, New Delhi.
13. Kushwath & Vijayakimar, 2001. Economics of Protected Areas and its management
14. Nicholas Poulin, 1977. Growth without ecodisasters.
15. Lenihan, J. and Fletcher, W.W., Environment and Man.
16. Hall, D.O., Economics of Ecosystem Management.

ESH452 ENVIRONMENTAL POLLUTION

UNIT I (13 hours)

Definition of environmental pollution: Types of pollution – Air, water, land, sound. Radioactive pollution; Transfer and Transport mechanism of pollutants.

UNIT II (13 hours)

Concepts of sources of air pollution: Gases & particulates and their components. Solid wastes – Sources of waste generation and disposal, characteristics of wastes. Effects on soil, biotic community, groundwater and air.

UNIT III (13 hours)

Sources of water pollution – Domestic, municipal, industrial and agriculture. Various water bodies as sites of waste disposal and their local, national and global impact.

UNIT IV (13 hours)

Bioindicators: Overview of bioindicators – theory, practices and problems; biondicators of air, water and soil pollution. Biomonitoring of heavy metals, biomontoring of air pollution around urban and industrial sites; organisms used as indicator of population.

References

1. Diwakar Rao, P.L, 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad, India.
2. Eaton, A.D., Clesceri L.S. & Greenberg, A.E., 1995. Standard Methods for the Examination of Water and Wastewater, APHA, Washington.
3. Moriarty, F., 1975. Pollutants and animals; A factual perspective. George Allan & Unwin Ltd., London.
4. Schmitz, R.J, 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
5. Trivedi, P.R. and Sudarshan, K., 1995. Global Environmental issues, Commonwealth Publications, New Delhi.

6. Vernberg *et al*., 1981. Biological monitoring of marine pollutants, Academic Press, New York.
7. George, A., 2000. The Ecology of sea shores, CRC Press.
8. Agrawal, K.C., 2002. Environmental Pollution: Causes, Effects and Controls.
9. Binoda C. Sabata, 1995. River Pollution in India.
10. Khetan S.K., 2000. Microbial Pest Control.
11. James, G.A., 1999. Ethical Perspective on Environmental issues in India.

SOFT CORE COURSES

ESS453 ENVIRONMENTAL CHEMISTRY

UNIT I (13 hours)

Environmental segment: Evolution of the atmosphere, composition & structure; hydrologic cycle; soil composition; bio-geochemical cycles (C, O, N, P, S, CO_2 etc.) Biodistribution of elements, chemical speciation.

UNIT II (13 hours)

Chemistry of atmosphere, air pollutants – sources, photo-chemical smog, green house effect, ozone depletion, acid rain (particulates - source and environment effects). Aerosols - sources, composition and environmental effect.

UNIT III (13 hours)

Chemistry of water: Ground and surface water composition, criteria and standards of water quality – organic, inorganic, radiological and microbial contaminants; Water purification for drinking and industrial process (Demineralization, desalination and reverse osmosis).

References

1. Levit, B.P., Fidlays practical physical chemistry, Longmann, London.
2. Yadav, 1989. Advanced practical physical chemistry.
3. Day, A.K. 1984. Environmental Chemistry, Willey Eastern, III Ed.
4. Faust, S.D. and Dly, O.M., 1983. Chemistry of water treatment, Butter
5. Sawyer, C.W. and McCarty P.L., 1978. Chemistry for Environmental Engineering, McGraw Hill.
6. Vogel, A.L. 1978. A text book of quantitative inorganic analysis. ELBS.
7. APHA, 1989. Standard methods for the examination of water and waste water, Washington D.C.
8. Ghosh G.K., 1999. Biopesticide and Integrated Pest Management.
9. Prabha Shastri Ranade, 2000. Industries and Environment. A study of Impact Assessment.

ESS454 ANALYTICAL AND STATISTICAL METHODS

UNIT I (13 hours)

Inorganic analytical methods: Coulometric titration – titration curves with EDTA, indicators, masking and damasking techniques. Principle, description and applications of chromatography, calorimetry, spectrophotometry, nephlometry/turbidometry, flame spectrometry, microscopy, Flourometry, X-ray fluorescence, radiometry, micrometry, AAS, GC/MS and NMR.

UNIT II (13 hours)

Introduction to basic statistics: Types of data - primary and secondary, collection of data, classification and tabulation of data. Diagrammatic and graphical representation of data – bar, pie, pictograms, histograms, frequency polygon, frequency curve and cumulative frequency curves.

Measures of central tendency - mean, median, mode; measures of dispersion – range, standard deviation, quartile deviation, mean deviation, relative measures of dispersion skewness and kurtosis, standard error, variance.

UNIT III (13 hours)

Distributions: Principles, properties and applications of binomial, poison and normal distributions. Theory of sampling, sampling distributions –'t', Chi- square, F distributions. Test of significance – 't' Test, Chi-square test, F-test. ANOVA- One way and two way classification.

Application of statistics in environment studies.

References

1. McGarigal, K., 2002. Multivariate statistics for Wildlife and Ecology Research, Springer Verlag New York.
2. Magurran, A.E., 1988, Ecological diversity and its measurement. Chapman & Hall, London.
3. Sokal, R.R. and Rohif, F.J., 1995. Biometry, 3rd Ed., W.H. Freeman, New York.
4. Wilkinson, L., 1989. SYSTAT: the system for statistics. SYSTAT Inc. Evanston, lllionois.
5. Zar, J.H., 1974. Biostatistical analysis. Prentice – Hall, Inc., Englewood Cliffs., NJ.
6. Christian, G.D., 1996. Analytical Chemistry, 4th Ed., John Wiley.
7. Day and Underwood, 1988. Quantitative analysis. Prentice Hall, India.
8. Srivasthava, A.K. and Jain, P.C., 1997. Chemical Analysis. S. Chand and Co. New Delhi.
9. Sawichi Mulik, Wittgen and Stoin, 1978. Ion Chromatographic analysis of Environmental Pollutants.
10. Williams and Wilson, 1984. A Biologist's Guide to Principles and Techniques of Practical Biochemistry.

11. Sndecor, G.W. and Cochran, W.G. Statisical Methods, Lowa state University Press.
12. Dixon, W.J. Massey Jr., F.J., McGraw Hill., Introduction to Statistical Analysis.
13. Fisher, R.A. Statistical Methods for Research Works, Oliver and Boyd, London.
14. Green, R.H., 1979. Sampling Design and Statistical Methods for Environmental Biologists, John Wiley & Sons.
15. Wardlow, A.C. 1985. Practical Statistics for Experimental Biologists. John Wiley and Sons.

ESS455 ENVIRONMENTAL HEALTH MANAGEMENT

UNIT I (13 hours)

Environmental health: Criteria, Chemical Safety; Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health; Water borne diseases - Prevention and protection of community health from water borne diseases.

UNIT II (13 hours)

Air borne bio-allergens, seasonal changes, mode of dispersal, disease intensity and control. Effects of Physical Environment on Accidents and Crime; Diseases of Man: Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system.

UNIT III (13 hours)

Food borne diseases: Types, symptoms and prevention. Food safety. Environmental sanitation. Effects of weather and climate on human health, working efficiency, traffic and industrial accidents.

References

1. Wisner, B. and Adams, J., 2002. Environmental Health in emergencies and disasters – A Practical Guide, World Health Organization.
2. Paul R. Hunter, 1997. Waterborne disease: Epidemiology and ecology, Chichester John Wiley and Sons Ltd.
3. Eaton, A. D., Clesceri, L.S. & Greenberg, A.E. 1995. Standard Methods for the Examination of Water and Wastewater. APHA, Washington.
4. Moriarty, F., 1975. Pollutants and animals: A factual perspective. George Allan & Unwin Ltd., London.
5. Atlas, RM and Bartha R. Microbial Ecology. Benjamin-Cummings Sci. Press, USA.
6. Beven, K., 2002. Rainfall-Runoff Modeling: The Primer.
7. Beaglehole, R., Bonita, R. and Kjellstrome, T. 2006. Basic epidemiology
8. Environmental Health - Emergency Response Guide, A supplement to local emergency preparedness and response plans, Advanced Practice Centres.

PRACTICAL COURSES

ESP456 SOCIO-ECONOMIC ASPECTS OF ENVIRONMENT LAB

1. Identification of geographical and natural resources location.
2. Population resources in India based on physical features.
3. Environmental laws and its impact: Matching of Acts and utilization of resources.
4. Identification of environmental movements. Year wise & region wise.
5. Measurement of sustainable development– working out sustainable developmental index in different regions and resources. Solving some problems.
6. Working out of impact assessment of different projects.
7. Economics of pollution abatement. Work out under different pollution agencies.
8. Identification of major pollutants and their effect on human and animal health.

ESP457 ENVIRONMENTAL POLLUTION LAB

1. Estimation of residual chlorine in the water sample using Chlorotex reagent.
2. Demonstration of catalase activity in polluted waters.
3. Estimation of oil and grease in water sample.
4. Solid waste indices.
5. Physical properties of solid waste.
6. Chemical characteristics of solid waste.
   - 6.1 Biological oxygen demand of solid waste.
   - 6.2 Chloride content of solid waste.
   - 6.3 Estimation of inorganic phosphate of solid waste.
   - 6.4 Estimation of sulphates of solid waste.
7. Indicators of pollution & biomonitoring.

ESP458 ENVIRONMENTAL CHEMISTRY LAB

1. Determination of dissolved oxygen in water samples.
2. Determination of total particulates in atmospheric air/chemical analysis.
3. Determination of phosphorus by sectrophotometry.
4. Determination of half life of radionuclides.
5. Determination of BOD in water samples.
6. Determination of COD in water samples.
7. Determination of nitrites and nitrates in water samples.
8. Instruments used in Environmental Chemistry.

ESP459 ANALYTICAL AND STATISTICAL METHODS LAB

1. Determination of calcium and magnesium from different samples.
2. Analysis of hardness in water samples.
3. Analysis of alkalinity in water samples.
4. Ion exchange separation of anions and cations
5. Spectrophotometric determination of silicates
6. Statistical analysis of experimental data.

ESP460 ENVIRONMENTAL HEALTH MANAGEMENT LAB

1. Quantitative and qualitative assessment of human pathogens in soil, water and air.
2. Isolation of human pathogens using selective media.
3. Identification of environmental agents causing allergic reactions in man.
4. Assessment of drinking water quality.
5. Study of water purification.
6. Analysis of emulsion activity and emulsion stability of flour samples.
7. Analysis of foam capacity and foam stability of flour samples.
8. Study of food preservation techniques and food safety equipments.

OPEN ELECTIVE COURSES

ESE461 BASIC SCIENCE CONCEPT IN ENVIRONMENT

UNIT I (13 hours)

Definition and scope of Environmental Science; Earth and its environment: Structure and Composition. Biosphere-Atmosphere, Lithosphere, Hydrosphere and Water cycle.

UNIT II (13 hours)

Atmosphere: Structure and composition. Temperature, pressure, humidity of atmosphere. Winds and clouds – their classification, formation and circulation, artificial rain, acid rain, global warming, green house effect.

UNIT III (13 hours)

Hydrosphere: Water as a resource, sources of water, water related issues, purification of water, water management.

Biogeochemical Cycles: Sedimentary cycles, gaseous cycles, cycling of heavy metals and radioactive compounds, Effect of anthropogenic activities on biogeochemical cycles.

References

1. Agrawal, K.C., 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Asthana D.K. and Meera Asthana, 2006. A text Book of Environmental Studies, S. Chand & Co. Ltd., New Delhi.

3. Clarke, G.L., 1974. Elements of Ecology, John Wiley & Sons, New York.
4. Odum, E.P., 1971. Fundamentals of ecology.
5. Arya, S.P., 2002. Introduction to Micrometeorology, 2nd Ed.
6. Gilbertson, D.D., Kent, M. & Pyatt, K.B., 1985. Practical ecology for Geography and Biology: Survey, Mapping and Data Analysis. Hutchinson.
7. Haines – Young, R.H. & Petch, J.R., 1986. Physical Geography: its nature and methods. Harper.
8. John, J.W.R. and Geoffrey, F.P. 1998. People and the Earth, Cambridge University Press.
9. Tucker, M., 1988. Techniques in Sedimentology. Blackwell.

ESE462 ENVIRONMENTAL EDUCATION AND LEGISLATIONS

UNIT I (13 hours)

Introduction to environment, components of environment – biosphere, atmosphere, lithosphere, hydrosphere; biotic and abiotic components; environmental problems including acid rain, ozone hole, global warming, deforestation; significance of environmental education and legislations.

UNIT II (13 hours)

Environmental Education: Definition, goals, objectives, principles; environmental education programmes; formal (primary and secondary school level and tertiary level) and non-formal environmental education; environmental education for professional groups. Environmental education in India – Status and policy of environmental education – Action Plan. Environmental Institutions and NGOs.

UNIT III (13 hours)

Environmental Legislations: Water Act -1974, Air Act - 1981, Environment (Protection) Act – 1986, Cess Act – 1977, Role of Parliament, State legislatives, Government departments including Pollution Control Boards in environmental protection. Environmental Protection Agencies/Organisations.

Legislation for protection of forest and wildlife in India, Indian Forest Act – 1927, Forest Conservation Act – 1980, Biodiversity Acts, Wildlife Protection Acts, Coastal Regulatory Zone (CRZ), Conservation Projects.

References

1. Agrawal, K.C., 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Pandey, G.N., 1998. Environmental Science and Technology, Annual Publication, New Delhi.
3. Asthana, D.K. and Meera Asthana, A text book of Environmental Studies, S. Chand & Co. Ltd., New Delhi.
4. Sharma, P.D., 2012. Ecology and Environment, Rastogi Publications, Meerut.

III SEMESTER

HARD CORE COURSES

ESH 501 ENVIRONMENTAL POLLUTION ABATEMENT 52 hrs.

UNIT I (13 hours)

Principles of pollution abatement – air, water, soil, noise pollution control principles; Basis and necessity for standards in drinking water, sewage, marine water, air and soil; Point and non-point pollution problems and remedies; Treatment methods of industrial, municipal and agricultural wastes, aerobic and anaerobic waste treatment methods of solid and liquid wastes.

UNIT II (13 hours)

Air pollution: Definition and types – indoor air pollution, particulates in air and their control and management, Instruments used in air sampling and air pollution control; emission standards; Pollution control and abatement methods in marine, brackish water and freshwater; standards for potable, industrial and irrigation purposes; Biomedical wastes.

UNIT III (13 hours)

Pollution control measures – soil, water, air and noise; International and national pollution regulatory Acts – Water Act, Air Act, Environment Protection Act, Cess Act, Factories Act, Biodiversity Acts, Biomedical Acts; Permissible levels of toxicants in the environment and pollution indices.

UNIT IV (13 hours)

Biological tools used in pollution abatement: Use of bacteria, fungi, actinomycetes, algae in bioremediation and biodegradation of wastes; Case studies on pollution abatement programmes at local, national and global levels; Case studies on Urban Solid Waste Management. Pollution abatement instruments. Recycling and reuse of solid and liquid wastes.

References:

1. Hosetti, B.B. and Arvind Kumar, 1998. Environmental Impact Assessment and Management, Daya Publishing House, Delhi.
2. Shukla, A.C., 1999. Advances in Environmental Pollution.
3. APHA, 1995. Standard methods for the examination of water and waste water 19th Edition, Washington, D.C.
4. Schimitz, R.J. 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
5. Khana, G.N., 2002. Environmental Problems, U.N APH Publishers.
6. Kumar, R., 1999. Environmental Pollution and Health Hazards in India.
7. Tripathy, D.B. Environmental Pollution Research.
8. Odum, Ecology.
9. Jogdanand, Environmental Biotechnology, Himalaya Publ. House.
10. Alexander, G., Microbial Biotechnology, WH Freeman and Co.
11. John Arundel, Sewage and Industrial Effluent Treatment, Blackwell Science Publ.

ESH 502 ENVIRONMENTAL PROTECTION 52 hrs.

UNIT I (13 hours)

Environmental protection principles: Instruments available - economic, social, religious, legal and cultural. Wildlife protection and preservation – IUCN categories of wildlife animals and plants; National parks, wildlife sanctuaries, zoos, bioreserves, botanical gardens; preservation of monuments; Animal rights, Wildlife protection laws.

UNIT II (13 hours)

Environmental protection of coastal environment: Marine environment, laws of the sea, coastal regulatory zone (CRZ), Hazardous wastes and management: Radioactive waste: Definition, types and disposal methods. Pharmaceutical waste: Types and management, Refinery waste: Types and disposal methods. Pesticide waste, detergent waste, plastic pollution and control.

UNIT III (13 hours)

Administrative and judicial remedies: Environmental institutions, Role of pollution control Boards in environmental protection; Sanctions and enforcement bodies of environment law, their jurisdiction and civil suits, specific relief and compensation, public interest and litigation, public participation in environmental decision making and actions.

UNIT IV (13 hours)

Pollution measurement and analysis: Sampling techniques for the analysis of air, water and soil samples; Interaction between man and environment: Environmental movements for environmental protection; Water and wastewater management; Water purification; Contaminated land management. Waste management and utilization (plantation crop wastes, domestic waste, poultry waste).

References:

1. Reddy, P.K., 2000. Wetland Ecology, Cambridge University Press.
2. Environmental Conservation and Planning.
3. Rodgers, W.H., 1977. Environmental Law.
4. The Environment (Protection) Act, 1986.
5. The Environment (Protection) Act, 1985.
6. Diwakar Rao, P.L. 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad. India.
7. Eaton, A. D., Clesceri, L.S. & Greenberg, A.E. 1995. Standard Methods for the Examination of Water and Wastewater. APHA, Washington.
8. Hommadi, A.H. 1990. Environmental and Industrial safety. Indian Bibliographics Bureau, Delhi.
9. Moriarty, F., 1975. Pollutants and animals: A factual perspective. George Allan & Unwin Ltd., London.

SOFT CORE COURSES

ESS 503 ENVIRONMENTAL IMPACT ASSESSMENT 39 hrs.

UNIT I (13 hours)

Environmental Impact Assessment: Definition, aim, components, methods and significance of impact assessment with case studies - Surveillance and monitoring, environmental conflicts. Preparation of impacts: Negative and positive impacts, primary and secondary impacts; impacts on physical, social and cultural aspects.

UNIT II (13 hours)

Sustainable development, unavoidable impacts; Alternative strategies. Integrated approach for environmental quality; Prediction of changes in the specific environmental components (air, water, noise, cultural, flora and fauna, socio-economic) due to projects; policies and planning, project implementation, national and international agencies involved in impact assessment studies.

UNIT III (13 hours)

Need for environmental impact assessment in industrialization, agricultural activities, urbanization; energy utilization-over exploitation. Environmental auditing-Definition, objectives, types, components, methodology, benefits, environmental audit in India; Applications and management of environmental impact assessment.

References:

1. Hosetti, B.B. and Arvind Kumar, 1998. Environmental Impact Assessment and Management, Daya Publishing House, Delhi.
2. Golden, J., 1979. Environmental Impact Data Book, Ann Arbor Science.
3. Hufschmidt, M.M. 1983. Environment, Natural Systems and Development – An Economic Valuation Guide, John Hopkins University Press, London.
4. Munn, R.E., 1989. Environment Impact Assessment, Scope 5.
5. Rau, J.G. and Woefen, D.C., 1980. Environmental Impact Analysis Handbook.
6. Hommadi, A.H. 1990. Environmental and Industrial safety. Indian Bibliographics Bureau, Delhi.
7. Moriarty, F., 1975. Pollutants and animals: A factual perspective. George Allan & Unwin Ltd., London.

ESS 504 ENVIRONMENTAL MANAGEMENT TOOLS 39 hrs.

UNIT I (13 hours)

Remote sensing: Principles and basic concepts. Earth observational satellites – Landsat, SPOT, NOAA for environmental monitoring, IRS series, remote sensing platforms, principles, Aerial platforms, aerial photography and its principles, Construction of Base maps and Thematic maps like vegetation resource map, geological resources map, soil resource map, water resource map etc. using IRS satellite data. GIS applications.

UNIT II (13 hours)

Information technology: Components of computers, hardware and software, machine language, compiler and interpreter, high level language, C language, Lotus, MS Word. Application of computer in environmental data analysis: Forecasting of weather, flooding, seismic data analysis; natural resource database management.

UNIT III (13 hours)

Application of statistics in environmental studies: Sampling techniques, Measures of Central tendency - Mean, Median and Mode; Frequency distribution, graphical and diagrammatic representations of data; Measures of Dispersion - Range, Variance, Standard deviation, Standard error. Tests of significance (X^2, `t' and 'F' tests), Regression and Correlation analysis. Analysis of variance, Statistical packages.

References:

1. Schultz, G.A., 2002. Remote Sensing in Hydrology & Water Management.
2. Vidal, A., Remote Sensing and Geographic Information Systems in Irrigation and Drainage; Methodological Guide and Applications.
3. Manual of Remote Sensing, 1980. Vol. I and Vol. II, American Society of Photogrammetry, 4th Ed., Falls Church.
4. Avery T.E and G.L Berlin, Interpretation of Aerial Photographs , 4th Ed, Bergress Minneapolis, Minn, 1985
5. Bruno Marcolongo and Franco Mantovani, 1997. Photogeology, Remote Sensing Applications in Earth Science, Oxford and IBH Publ. Co. Pvt., New Delhi.
6. Pandey, S.N., 1987. Principles and Applications of photogeology, Wiley Eastern.
7. Rees, W.G., 1990. Physical Principles of Remote Sensing, Cambridge University Press.
8. Sabins, F.F., 1986. Remote Sensing Principles and Interpretations, 2nd Ed., W.H Freeman and Company, New York.
9. Siegel, B.S. and Gillespie, A.R. (Eds.), 1980. Remote Sensing in Geology, John Wiley and Sons, New York.
10. Thomas, M., Lillesand and Ralph W Kiefer, Remote Sensing and Image Interpretations, John Wiley and Sons, New York, 1994.
11. Verbyla, D., 1995. Satellite remote sensing for natural resources; Lewis Publishers, Boca Rotaon, FL.
12. Wolf, P.R., 1983. Elements of Photogrammetry, 2nd Ed., McGraw-Hill, New York.
13. Nishit Mathur, 2010. Fundamentals of Computers, Aph Publishing Corporation.

14. Norman, T. J. and Bailey. II Edn. Statistical methods in Biology. Hodder and Stonghton Ltd.

ESS 505 HUMAN POPULATION AND ENVIRONMENT 39 hrs.

UNIT I (13 hours)

Population status in India and the world, population growth and explosion, family welfare programme. Measurement of population - Natality and Mortality, Population density, pattern of population distribution; population dispersal - Emigration, Immigration and Migration; Environmental problems of population growth.

UNIT II (13 hours)

Environment and human health, human rights, value education, women and child welfare, role of environmental education in the management of environment, Environmental Education Programmes, Formal Environmental Education (Primary, secondary and tertiary school level), Non-formal Environmental Education (meetings, public lectures, exhibition etc.).

UNIT III (13 hours)

Role of natural resources in the human development, role of human society in the conservation of forest, river, ponds and other natural resources, role of women in environmental conservation; medicinal plants and their role to control human population from disease. Traditional ecological knowledge.

References:

1. Agrawal, K.C., 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Lori M. Hunter, 2000. The Environmental Implications of Population Dynamics, Rand Corporation.
3. Don Melnick, 2005. Environment and Human Well-being - A Practical Strategy, Earthscan.
4. Sharma, P.D. 1975. Elements of Ecology, Rastogi Publications, Meerut.
5. Sharma, P.D., 2012. Ecology and Environment, Rastogi Publications, Meerut.

PRACTICAL COURSES

ESP 506 ENVIRONMENTAL POLLUTION ABATEMENT LAB

1. Air pollution monitoring, devices, samplers.
2. Estimation of DO in water samples.
3. Estimation of BOD in water samples.
4. Determination of chlorinity and salinity in water samples
5. Study of primary and secondary abatement methods.
6. Detection of pathogenic bacteria in water.
7. Detection of pathogenic cyanobacteria in polluted waters.
8. Study on instruments related to measurement of radioactive compounds.
9. Noise pollution control instruments
10. Practicals on pollution related issues.
11. Visits to factories, laboratories, industries like KIOCL, M.C.F., dairy industry.

ESP 507 ENVIRONMENTAL PROTECTION LAB

1. Estimation of alkalinity in water and soil samples.
2. Estimation of phosphate in water and soil samples.
3. Estimation of sulphate in water and soil samples.
4. Estimation of silicate in water and soil samples.
5. Study on soil size and texture.
6. Solid waste indices.
7. Estimation of physical parameters of solid waste.
8. Estimation of chlorinity in solid waste samples.
9. Estimation of phosphate in solid waste samples.
10. Estimation of sulphate in solid waste samples.
11. Estimation of silicate in solid waste samples.
12. Study of important environmental movements to protect environment.

ESP 508 ENVIRONMENTAL IMPACT ASSESSMENT LAB

1. Assessment and prediction of impact on air and water.
2. Assessment and prediction of impact on flora and fauna.
3. Criteria for EIA of water related projects.
4. Criteria for transport related EIA.
5. Environmental guidelines for EIA of industrial establishments.
6. Measurement of suspended particulate matter in air.
7. Study on agricultural activities and their impact on environment.
8. Impact on environment due to urbanization.
9. Preparation of model environmental audit report for the financial year ending 31st March for any industry/process/operation.

ESP 509 ENVIRONMENTAL MANAGEMENT TOOLS LAB

1. Practical exercises on environmental monitoring and remote sensing platforms.
2. Practical exercises on aerial platforms and aerial photography.
3. Practical exercises on geological resource maps
4. Practical exercises on vegetation resource maps and water resource maps.
5. Exercises related to spectral reflectance - vegetation, soil, and water.
6. Introduction to computing in geography.
7. Practical applications like programming concepts.
8. Analysis and interpretation of spatial and geographic data and graphics.
9. Study on softwares for weather forecast.
10. Problems on Statistics for environmental data.

ESP 510 HUMAN POPULATION AND ENVIRONMENT LAB

1. Study on population growth.
2. Graphical representation of world population.
3. Graphical representation of Indian population.
4. Diagrammatic representation of population growth rates.
5. Regional population growth.
6. Collection of some common medicinal plants grown around, identify and comment on their medicinal properties.
7. Measurement of population.
8. Study on population density - mark the places where the population density is high or low in Indian and world map.

OPEN ELECTIVE PAPERS

ESE 511 NATURAL RESOURCES 39 hrs.

UNIT I (13 hours)

Natural Resources: Classification, uses, distribution; Threats to natural resources; Protection and conservation of natural resources – air, water, soil, forest resource, wildlife resource, fossil fuel, mineral resource. Management of natural resources.

UNIT II (13 hours)

Renewable energy sources: Definition, classification, solar energy - solar cells and solar photovoltaic technology, solar thermal technology, solar energy programmes; wind energy, wind energy programmes; hydropower - hydel projects in India; Geothermal energy, Geothermal energy programmes; Ocean energy – Tidal power, thermal energy, wave energy, salinity energy; biogas, biogas programmes.

UNIT III (13 hours)

Non-renewable energy sources: Definition, classification. Coal-composition, petroleum-components and refinery process, natural gas-reserves, fuel wood. Nuclear Power – Nuclear reactors – types. Energy crisis and conservation of energy resources. Management of biotic and abiotic energy sources.

References:

1. Rajendra Maneria, Environment Conservation and Planning.
2. Khenshoo, T.N., Environment Concerns and Strategies.
3. Tiwari, S.K., 1997. Wildlife Sanctuaries of Madhya Pradesh.
4. Khan, T.I., 2000. Global Biodiversity and Environment Conservations. Pointer Publishers, Jaipur.
5. Bennett, H.H., 2002. Soil Conservation.
6. Deka, M.M., 2002. Joint Forest Management of Water Projects.
7. Gangstad, E.O., 2002. Environment Managements of Water Projects.
8. Maitra, M.K., 2002. Watershed Management; Project, Planning, Development and Implementation.
9. Ural, O., 1980. Soil and Water Conservation.

ESE 512 WASTE MANAGEMENT 39 hrs.

UNIT I (13 hours)

Waste: Introduction. Classification - Solid waste and liquid waste; Solid waste - Definition, classification and components; Municipal, industrial, domestic, hazardous waste, biomedical waste; environmental standards-emission standards, drinking water standards, Effects of solid waste on environment, physical and chemical properties of solid waste.

UNIT II (13 hours)

Liquid waste: Sewage and effluents, effect of liquid waste on environmental components. Microbiological treatment of solid wastes – composting, land farming, bioreactors. Physical, chemical and biological treatment of liquid waste. Disposal of radioactive, pharmaceutical, refinery and leather waste.

UNIT III (13 hours)

Treatment of solid and liquid waste: Solid waste Management. Biological treatment of liquid wastes - aerobic and anaerobic treatment of sewage and effluents. Waste management and utilization of plantation crop wastes, aquatic weeds, kitchen, garden and poultry waste. Recycling and reuse of solid and liquid wastes.

References:

1. Agrawal, K.C., 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Hosetti, B.B. and Arvind Kumar, 1998. Environmental Impact Assessment and Management, Daya Publishing House, Delhi.
3. John Arundel, Sewage and Industrial Effluent Treatment, Blackwell Science Publishers.
4. Metcalf and Eddy, Waste Water Engineering, McGraw-Hill International.
5. Diwakar Rao, P.L. 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad. India.
6. Moriarty, F., 1975. Pollutants and animals; A factual perspective. George Allan & Unwin Ltd., London.
7. Schmitz, R.J, 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.

IV SEMISTER

HARD CORE COURSES

ESH 551 ENVIRONMENTAL BIOTECHONOLOGY 52 hrs.

UNIT I (13 Hours)
Bioremediation: Microbial bioremediation, *in situ* and *ex situ* bioremediation, phytoremediation; Ex-situ and in-situ conservation; Gene reserves and germplasm bank, cryopreservation, embryo transfer, Transgenic organism in the environment.

UNIT II (13 Hours)
Natural products: By-products from terrestrial and aquatic organisms, By-products from industrial, agriculture and domestic sources and their utilization. Microbial degradation of pesticide, detergent, plastic, hydrocarbons, textiles, leather and wood.

UNIT III (13 Hours)
Mariculture, biomolecules from marine organisms, biofilms, biofouling and its prevention. Microbial mining, microbial influenced corrosion and remedies, bioaccumulation, biomagnification, biogas production and utilization.

UNIT IV (13 Hours)
Key molecular technologies for biodiversity assessment and monitoring: DNA recombination, DNA sequencing, PCR techniques and DNA fingerprinting. Intellectual property rights, patenting, traditional knowledge and traditional knowledge digital library (TKDL), biopiracy, plant-related litigations, bioterrorism and biological warfare.

References:

1. Old, R.N. and Primrose, S.B. 1994. Principles of Gene Manipulation, Blackwell Scientific Publications.
2. Watson et al., 1992. Recombinant DNA, Scientific American Books.
3. Calendar, 1988. The Bacteriophage, Vol II, Plenum Press.
4. Young, M.M., 1985. Comprehensive Biotechnology, Vol. 2, 3 & 4, Pergamon Press.
5. Prave, P., Faust W, Sitting V. and Sukatesh, D.A. 1987. Fundamentals of Biotechnology, WCH, Weinhein.
6. Stanbury, P.F. and Whitaker, A. 1984. Principles of Fermentation Technology.
7. Lycett, G.W. and Grierson, D. 1990. Genetic Engineering of Crop Plants.
8. Chrispeels, M.J and Sadava, D. F. 1994. Plants, Genes and Agriculture.
9. Glover and Hames, B. D. 1995. DNA Cloning I & II IRL Press.
10. Gelfand and Sninskey, J.J. 1995. PCR Strategies, Academic Press.

SOFT CORE CORSES

ESS 552 ENVIRONMENTAL CONSERVATION AND MANAGEMENT 39 hrs.

UNIT I (13 Hours)

Objectives of conservation, concepts of conservation and preservation, development and conservation, conservation of natural resources - air, water, biota. Regional, national and global conservation strategies.

UNIT II (13 Hours)

Methods of conservation: Gene reserves, biosphere reserves, national parks, sanctuaries, national heritage; phytoclimates of Peninsular India, botanical gardens, extinction of species, concepts of threatened, rare, vulnerable and endangered species.

UNIT III (13 Hours)

Biodiversity conservation: Framework for managing biodiversity; priorities for conservation, sustainable use of biodiversity for natural resource management, protecting ecosystems, species, populations and genetic diversity. Capacity building for resources management; Institutions at local, regional, national and global levels.

References:

1. Rajendra Maneria, Environment Conservation and Planning.
2. Khenshoo, T.N., Environment Concerns and Strategies.
3. Tiwari, S.K., 1997. Wildlife Sanctuaries of Madhya Pradesh.
4. Khan, T.I., 2000. Global Biodiversity and Environment Conservations. Pointer Publishers, Jaipur.
5. Bennett, H.H., 2002. Soil Conservation.
6. Deka, M.M., 2002. Joint Forest Management of Water Projects.
7. Gangstad, E.O., 2002. Environment Managements of Water Projects.
8. Maitra, M.K., 2002. Watershed Management; Project, Planning, Development and Implementation.
9. Ural, O., 1980. Soil and Water Conservation.

ESS 553 ENVIRONMENTAL TOXICOLOGY **39 hrs.**

UNIT I (13 Hours)

Introduction, definition and various facets of toxicology; Kinds of toxicity, time and dose response relationships; factors influencing the toxicity; Bioassay. Metabolism of toxic substances: biomagnification, biotransformation and detoxification; Effects of environmental toxicants- sub cellular, cellular, individual, population and ecosystem levels.

UNIT II (13 Hours)

Atmospheric toxicants: Major sources, types and standards; Primary pollutants-Carbon monoxide, sulphur oxides, nitrogen oxides, particulate matter, hydrocarbons, asbestos and CFC's; Secondary pollutants; Impact of air pollutants on climate-Acid rain, photochemical smog, global warming, ozone depletion and haze. Toxicity of Alcohol, tobacco and its products, food additives.

UNIT III (13 Hours)

Pesticides: Definition, classification; Insecticides: Organochlorines, Organophosphates and carbamates. Poisoning and treatment; Herbicides, fungicides, rodenticides, endocrine disrupters. PCBs and Dioxins. Toxic risk assessment: Methods, monitoring, importance and surveillance of risk assessment. Safety standards: Safety measures, safety regulations, protective practices and devices.

References:

1. Boudou, A. 1997. Aquatic toxicology. Vol. I and II.
2. Diwakar Rao, P.L., 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad. India.
3. Eaton, A. D., Clesceri, L.S. and Greenberg, A. E. 1995. Standard Methods for the Examination of Water and Wastewater, APHA, Washington.
4. Gupta, P.K. and Salunke, D.K. 1985. Modern Toxicology. Vol. I, II and III. Metropolitan Publications, Delhi.
5. Hommadi, A.H., 1990. Environmental and Industrial safety. Indian Bibliographic Bureau, Delhi.
6. Jorgensen, S.E., Modelling in Ecotoxicology. Elsevier, Amsterdam.
7. Lewin, S.A. et al., 1988. Ecotoxicology: Problems and approaches. Springer - Verlag, Tokyo, New York.
8. Lewin, S. A. et al., 1989. Ecotoxicology: Problems and approaches. Springer - Verlag, Tokyo, New York.
9. Moriarty, F., 1975. Pollutants and animals: A factual perspective. George Allan & Unwin Ltd., London.
10. Omkar, 1995. Concepts of Toxicology. Chand & Co., Jallandar.
11. Schmitz, R.J., 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
12. Trivedi, P.R. and Sudarshan K., 1995. Global environmental issues. Commonwealth Publications, New Delhi.

13. Vernberg et al., 1981., Biological monitoring of marine pollutants. Academic Press, New York.

PRACTICAL COURSES

ESP 554 ENVIRONMENTAL BIOTECHNOLOGY LAB

1. Microbiological assays: Amino acids, vitamins, and antibiotics.
2. Microbial fermentation; ethyl alcohol, volatile fatty acids and antibiotics (from bacteria, antinomycetes and yeasts.
3. Biotransformations and assessment of production of microbial enzymes by bacteria, actinomycetes and fungi.
4. Production of secondary metabolites from microbes.
5. Animal tissue culture -Techniques of growing cells.
6. Plant tissue culture.
7. Restriction endonucleases on DNA separation- DNA fragments.
8. Biofilm development.
9. Worm culture.
10. Practicals on Computer.

ESP 555 ENVIRONMENTAL CONSERVATION AND MANAGEMENT LAB

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use-t-test for comparing two means related to ecological data.
2. To prepare ombrothernic diagram for different sites on the basis of given data set and to comment on climate.
3. To find out the relationship between two ecological variables using correlation and regression analysis.
4. To determine minimum size and number of quadrates required for reliable estimate of biomass in grasslands.
5. To find out association between important grassland species using Chi-square test.
6. To compare protected and unprotected grassland stands using community coefficients (similarity indices)
7. To analyse plant communities using Bra-Curtis ordination method.
8. To determine diversity indices (Shannon-Wiener, concentration of dominace, species richness, equaitability and B-diversity) for protected and unprotected grassland stands.
9. To estimate IVI of the species in a woodland using point centered quarter method.
10. To determine gross and net phytoplankton productivity by light and dark bottle method.
11. To determine soil moisture content, porosity and bulk density of soil collected from varying depths at different locations.
12. To determine the water holding capacity of soils collected from different locations.
13. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
14. To estimate the dissolved oxygen content in eutrophic and oilgotrophic water samples by azide modification of Winkler's method.
15. To estimate the chlorophyll content in SO2 fumigated and unfumigated plant leaves.

16. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
17. To study environmental impact of a given developmental activity using checklist as a EIA method.

ESP 556 ENVIRONMENTAL TOXICOLOGY LAB

1. Safety notices in environmental toxicological studies.
2. Bioassay experiments using different test systems.
3. Behavioral study of the fish under exposure to toxicants.
4. Estimation of oxygen consumption by the organism (fish) under stressed condition (physical & chemical).
5. Experiments on solid waste
6. Estimation of oil and grease in water sample.
7. Demonstration of catalase activity in polluted waters.
8. Spot test for detection of metals, residual chlorine, nitrite poisoning, fluoride toxicity, food adulterants and pesticide residues.
9. Effect of $CdCl_2$ on germination of Bengal gram.
10. Effect of toxicants in meristematic tissue (Onion root tips).
11. GC analysis of pesticide residues in food samples.

PROJECT WORK

ESP 557 Project work (Report/Dissertation)