

**D R. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.**



**Curriculum under Choice Based Credit &
Grading System
M.Sc. I & II Year
Environmental Science
Semester-I to IV**

**run at college level from the
Academic Year 2015-16 & onwards**



**DR. BABASABEB AMBEDKAR MARATHWADA
UNIVERSITY
AURANGABAD**

Syllabus

Of

**M.Sc. (Environmental Science)
Ist and IInd Year**

**Under
(Academic Flexibility)**

In

Choice Based Credit System(CBCS)

Effective from Academic Year

June 2011-2012 onwards

Introduction and Scope

Environmental Science is one of the most important subjects having basic and applied components and which deals with interaction among physical, chemical and biological components of the environment and provides an integrated and interdisciplinary approach to study the environmental systems.

Since most of the environmental issues are related with various kinds of human activities, mostly local and global environmental problems are associated with human developmental activities.

The pollution problems viz air, water, soil, noise, radiation and pesticide pollution etc. are increasing along with the human's developmental activities. The degradation of environment is directly proportional to the exploitation and utilization of natural resources needed for development, making environment inhabitable to mankind and living organisms.

If the mankind has to maintain his environment in good condition, it is necessary to conserve the resources available in his environment and offer protection to it from further degradation of its quality.

The conservation of environment needs technical personal who can understand the complex environment and environmental problems in detail and able to mitigate them by developing an alternative techniques or clean developmental mechanisms etc. or by giving an appropriate sustainable developmental policies and programmes, which are needed to the society in 21st century.

The environmental education is one of the important tool through which the goals of sustainable development can be achieved. Therefore the main objective of environmental education is to disperse the knowledge of environment in younger generation through formal education system and produce knowledgeable, skilled and environmentally aware persons who can participate in solving real life environmental problems and actively participate in environmental conservative movements. The environmental education will give holistic, integrated and unbiased approach to young students.

Worldwide different environmental movements are lead by environmentally conscious society members for protecting earth's environment and to promote such kinds of conservative culture among the society by celebrating world forest day (21st March), World Environment Day (5th June) and World Ozone Day (16th September) etc. and the environmental education may provide such kind of opportunities to younger generation to participate in environmental activities.

By considering the importance of environmental conservation, the issue of environment protection is the political agenda at global level.

The career opportunities in environmental science are expanding rapidly due to Governments policies and legal regulations. There are good

numbers of opportunities in the private sector as well in Government sector. After completion of post graduation the students may get an opportunity in the State Pollution Control Board, Central Pollution Control Board, Research Institutions, Educational Institutions, NGO, Consultancy, Industries etc.

Therefore important aim of the M. Sc. Environmental Science course is to produce technically skilled manpower in the field of environment, which is able to solve the environmental problems.

Eligibility conditions:

Admission to M.Sc. Environmental Science shall be made on the merit basis of aggregate percentage of optional subjects of three years degree course. The weightage of 1% will be given to the candidates who offered Environmental Science as one of the optional subject at the B.Sc. level for seeking the admission to the M.Sc. Environmental Science.

B.Sc. with Environmental Science, Botany, Zoology, Physics, Chemistry, Microbiology, Biochemistry, Bio-Technology, Earth Science etc., B.E.(Civil/Environmental Engineering) and B.Sc. Agriculture subjects, shall be held eligible for the admission to M.Sc. in Environmental Science

Course structure:

The M.Sc. Environmental Science under **Academic Flexibility in Choice Based Credit System** contains 17 theory papers and 15 practical papers. The theory papers are of 4 credits each. All the practical papers are of 2 credits except Practical paper –XV_{th} which is project work having 4 credits.

The M.Sc. Course is of two years period with 100 Credits of 2500 marks. The course is divided in to four semesters. In every semester student has to appear for 24 Credits of 600 marks except third semester which is of 28 credits of 700 marks. One paper ENV- 522 of 4 Credits of 100 marks from IIIrd semester will be a **Service Course** to the students from the same or other departments.

During the two years study course students has to earn the credits form 80 credits core course, 16 credits elective course, and 04 credits service course.

For the successful completion of M.Sc. Course in Environmental Science, candidate has to complete 100 Credits courses out of 2500 marks. In all semesters from I to IV , three theory papers will be core courses(CC) and one elective course(EC), where as in III semester there will be one service course(SC) which students has to opt it either from the mother department or from the other department.

Course Structure
M.Sc. [Environmental Science] In Choice Based Credit System
under (Academic Flexibility)
100 credits against 2500 marks.

Year	Sem-ester	Course	Course Code	Paper Title	Credits	Marks
I Year	I	CC	ENV- 401	Fundamentals of Environment	4	100
		CC	ENV- 402	Environmental Chemistry	4	100
		CC	ENV- 403	Environmental Instrumentation & Analysis	4	100
		EC	ENV- 421 A	Wildlife Conservation & Management	4	100
		EC	ENV- 421 B	Environmental Meteorology & Geosciences	4	100
		CC	ENV – 441	Practical Paper - I	2	50
		CC	ENV- 442	Practical Paper - II	2	50
		CC	ENV- 443	Practical Paper – III	2	50
		CC	ENV- 444	Practical Paper - IV	2	50
	II	CC	ENV- 404	Environmental Pollution Studies	4	100
		CC	ENV- 405	Environmental Microbiology & Biotechnology	4	100
		CC	ENV- 406	Natural Resources & Sustainable Development	4	100
		EC	ENV- 422 A	Environmental Statistics & Modeling	4	100
		EC	ENV- 422 B	Environmental Management Systems	4	100
		CC	ENV- 445	Practical Paper – V	2	50
		CC	ENV- 446	Practical Paper – VI	2	50
		CC	ENV- 447	Practical Paper - VII	2	50
		CC	ENV- 448	Practical Paper – VIII	2	50

II Year	III	CC	ENV- 501	Pollution Control Technology	4	100
		CC	ENV- 502	Industrial Safety Management	4	100
		CC	ENV- 503	Environmental Toxicology & Biodiversity	4	100
		EC	ENV- 521 A	Environmental Legislation & Policies	4	100
		EC	ENV- 521 B	Ecological Footprints and Carbon Sequestration	4	100
		SC	* ENV- 522	Climate Change & Global Environmental Issues	4	100
		CC	ENV- 541	Practical Paper – IX	2	50
		CC	ENV- 542	Practical Paper – X	2	50
		CC	ENV- 543	Practical Paper – XI	2	50
	CC	ENV- 544	Practical Paper - XII	2	50	
	IV	CC	ENV- 504	Remote Sensing & GIS	4	100
		CC	ENV- 505	EIA & Environmental Audit	4	100
		CC	ENV- 506	Hazardous Waste Management	4	100
		EC	ENV- 523 A	Disaster management	4	100
		EC	ENV- 523 B	Advanced Technologies & CDM	4	100
CC		ENV- 545	Practical Paper - XIII	2	50	
CC		ENV- 546	Practical Paper - XIV	2	50	
CC		ENV-547	Practical Paper – XV Project Work	4	100	

Note:

- i) For theory paper 1 credit = 15 hours and for practical paper 1 credit = 30 hours. (CC- Compulsory course; EC- Elective course; SC- Service Course).
- * ii) Paper no ENV- 522 is a Service Course.
- iii) Env -547 : The selection of topic for dissertation will be assigned at the end of II semester and assessment will be conducted at the end of IV semester during practical examination.
- iv) There will be compulsory summer in-plant training for one month after the examination of II semester. This will be internal assessment of the practical paper XV.

Courses:

1. **Core course (C.C)** : Core course is a course that a student admitted to a particular P.G. Program must successfully complete to receive the degree. Normally no theory course shall have more than four credits.
2. **Elective Course (E.C)** : Elective course means an optional course from the basic subject or specialization.
3. **Service Course (S.C)** : Service course will be offered in IIIrd semester. Students must complete a service course for securing M.Sc degree.
4. Each course shall include lectures/ tutorials/laboratory or field work/seminar/practical training/assignments /mid-term and term end examination/paper/report writing or review of literature and any other innovative practice to meet effective teaching and learning needs.
5. **Attendance:** Student must have 75% attendance in each core and elective course for appearing the examination. However student having 65% attendance with medical certificate from civil surgeon may apply to the H.O.D for condonation of attendance.
6. The student will have to register the service course of his interest after the start of semester in the concerned department on official registration form. The teacher in charge of the respective course will be given from the date of admission for completion of registration procedure. The Departmental Committee will follow a selection procedure after counseling to the students etc. to avoid overcrowding to particular course(s) at the expense of some other course.
7. The department will decide the maximum number of students in each service course taking into account the teachers and Physical facilities available in the Department.
8. No service course will be offered unless a minimum of 10 students are registered.

Examination:

There will be continuous assessment of students in 80:20 External: Internal pattern in theory and practical examination.

The internal assessment for 20% marks will be made by taking tests, tutorials, assignments, class seminars, attendance, discipline and overall performance etc. by scaling down. There will be two mid-term tests and two tutorials in each semester for each theory (compulsory and elective) papers. One seminar on each theory (compulsory and elective) paper has to be given in each semester. The student has to complete whole assignment within prescribed schedule.

A) Structure for theory paper

Test-I	Test-II	Two Tutorials/ Assignments	One Seminar	Attendance, Discipline & Overall performance etc.	Total 50 marks will be scale down to 20 as an internal mark for each theory paper.
10 marks	10 marks	10 marks	10 marks	10 marks	

B) Structure for practical paper.

Test-I	Record	Field visit	Attendance & Discipline	Viva- voce & Overall performance etc.	Total 50 marks will be scale down to 10 as an internal mark for each practical paper.
10 marks	10 marks	10 marks	10 marks	10 marks	

The theory and practical examinations will be held at the end of each semester. There will be combine passing (internal marks + external marks) after getting at least minimum 40% marks in each paper.

Every student will have to complete 100 credits to obtain the masters degree in Environmental Science having practical's/ laboratory work / Field work / demonstration work etc., of which 96 credits should be from their respective subject and four (04) credits from service courses.

Question paper pattern:

A) For Theory paper: - Each theory paper is of 100 marks. In 80:20 pattern there will be 20 internal marks. The external examination is of three hours duration and of 80 marks. The question paper format is as follows:

There will be two parts. Part first is compulsory question of 20 marks consist of short questions / fill in the blanks / multiple choice questions / match columns / state true or false / answer in one sentences.

Part B will consist 7 questions of which student will have to answer any five questions. The theory examination is of three hours and of 80 marks.

Time- Three hours; Total marks—80

Solve any five questions from Q 2 to Q 8.

Q. 1:- Compulsory Short questions	-----	20 Marks.
Q.2:- Long question	-----	12 Marks
Q. 3:- Long question	-----	12 Marks.
Q.4:- Long question	-----	12 Marks
Q. 5:- Long question	-----	12 Marks
Q. 6:- Long question	-----	12 Marks
Q.7:- Long question	-----	12 Marks
Q.8:- Long question	-----	12 Marks

B) **For practical:-** Each practical paper is of 50 marks, except Practical paper XV which is project having 100 marks. In 80:20 pattern the assessment of 40 marks practical paper through external and 10 marks by internal. The practical examination is of six hours. The model question paper for practical examination of semester I to IV for Practical Paper I to XIV is as follows:

Time- Four Hours.	Total Marks - 40
Q. 1:- Long question	----- 12 Marks.
Q. 2:- Long question	----- 10 Marks
Q. 3:- Short question	----- 10 Marks
Q. 4:- Record Book	----- 04 Marks
Q. 5:- Viva-voce	----- 04 Marks

For the Practical Paper XV the question paper will consists of 80 marks for external (Project work and Field visit) and 20 marks for internal assessment (In-plant training).

The external assessment format is as follows.

Time: Six hours.	Total marks-80
i) Dissertation	----- 75 Marks
ii) Tour Report / Field Visit Report	----- 05 Marks
Split up of 80 marks (Dissertation)	
a) Submission of dissertation	----- 40 marks
b) Presentation skill	----- 20 marks
c) Question – answer (open defense)	----- 15 marks
d) Tour report / Field visit report	----- 05 marks
Spit up of 20 marks (In-plant Training's internal marks)	
a) Submission of In-plant Training Report along with certificate	----- 10 marks.
b) Presentation skill	----- 05 marks
c) Question- answer (Open defense)	----- 05 marks

(Academic Flexibility)
M.Sc. Environmental Science, Part I, Semester – I
[Core theory course with 04 credits]

ENV- 401: Fundamentals of Environment

Unit – I: Introduction to Environment

Definition, principle and scope of environmental science, man & environment, media and people, decision making and applications in environmental science, environmental ethics, environmental consciousness.

Unit -II: Components of Environment:

Atmosphere: structure and composition atmosphere.

Lithosphere: structure and composition of lithosphere, soil: composition of soil, soil formation: physical, chemical, biological weathering, soil profile, properties of soil: physical, chemical and biological soil erosion.

Hydrosphere: Hydrological cycle, structure and composition of hydrosphere, global water balance, types of water, factors influencing the surface water, ground water exploration, rain water harvesting.

Biosphere: Concept of biosphere, physical, chemical and biological factors of environment.

Unit -III: Ecosystem dynamics:

Concept of ecosystem, abiotic and biotic components, energy in ecological system, concept of productivity, energy flow in ecosystem, food chain, food web, ecological pyramids, cybernetic nature and stability of ecosystem, Concept of Habitat, ecological niche, guild, concept of ecotone, edge effect, ecological succession, mechanism of succession, concept of climax, concept of Gaia hypothesis.

Unit IV: Restoration of Degraded ecosystems : Ecological restoration of degraded ecosystems such as, forest, grassland, desert ecosystem, lentic and lotic ecosystems, coastal ecosystems etc. , role of pioneer species in restoration, major biomes of world.

Unit- V: Population and community ecology: Concepts of population ecology, population dynamics, characteristics of population: natality, mortality, fecundity, density, age distribution, prey predator relationship, population explosion; Concept of community, interspecific and interspecific competition, concept of carrying capacity ecological sustainability.

Current developments in the subject.

Recommended Books:

1. Fundamentals of Ecology – E.P. Odum, Revised Edition 1995-96
2. Principles of Ecology – P.S. Verma, V.K. Agarwal, S. Chand and Co. Delhi.
3. Principles of Environmental Science – Wart K.E.F. (1973) Mc Graw Hill Book Company.
4. Ecology – M.P. Arora
5. Basic Ecology – E.P. Odum
6. Concept of Ecology – E.J. Koromondy, 1996, concept of modern biology series, prentice Hall.
7. Modern Concepts of Ecology – H.D. Kumar
8. Principles of Environmental Biology – P.K.G. Nair, Himalaya pub. House, Delhi
9. Environmental Biology – P.D. Sharma, Rastogi Publication, Meerut.
10. Ecology and Environment - P.D. Sharma, Rastogi Publication, Meerut.
11. Basic concepts of soil science – A.K. Kolay, Willey estern ltd., New Delhi.
12. Environmental Science – Enger, Smith, Smith, W.M.C. Brown company publishing
13. Principles of soil environmental science – Watt, K.E.F. (1973), Mc Graw Hill Book Company, New Delhi.
14. Practical Method in Ecology – R.K. Trivedi, P.K. Goel and Trisal., Enviro Publication, Karad.
15. Chemical methods for Environmental Analysis Water and sediments – R.Ramesh, M. Anbu. Macmillan India Ltd. New Delhi.
16. Fundamental of Ecology – Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.
17. Concepts of Ecology (Fourth Edition)- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
18. Environment forest, ecology and man – Dixit R.K. Rastogi Publication, New Delhi.
19. Physical geography – Dasgupta
20. Environment, energy, health planning for conservation – V. Vidyanath, Gyan Publishing House, New Delhi.

[Core theory course with 04 credits]
ENV- 402: Environmental Chemistry

Unit – I: Basic concepts of Environmental Chemistry: Energy-Definition, types (kinetic and potential), forms of energy; laws of thermodynamics (First & Second), Stoichiometry, Gibbs energy, chemical potential, chemical equilibrium, acid-base reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide.

Unit -II: Chemistry of air: Classification of elements; composition of air; chemical speciation; particles ions and radicals in the atmosphere; chemical processes for formation of inorganic and organic particulate matter. Toxic chemicals in environment, pesticides, insecticides, arsenic, cadmium, lead, mercury, carbon monoxide and ozone, MIC and other carcinogens in air and water.

Unit -III: Chemistry of water and soil: Chemistry of water; structure of water molecule; solubility of compounds in water; dissociation constant; water quality parameters and standards. Chemistry of Soil: composition of soil; biogeochemical cycles (nitrogen, oxygen, carbon, sulphur, phosphorus etc); micronutrients of soil; factors affecting the soil quality; adsorption of contaminant in soil; toxic chemicals present in soil.

Unit -IV: Green House Effect: Introduction; sources of green house gases; major green house gases; impact of green house gases on global climate; consequences of green house effects; remedial measures of green house effects; impact of global warming on-human health, agriculture, biodiversity etc.

Unit- V: Ozone layer depletion and photochemical smog : Formation of ozone; mechanism of ozone depletion; Antarctic and Arctic ozone hole formation ; effects of ozone depletion; climatic effects of ozone depletion.CFC and ozone layer depletion; Chemical aspects of acid rain and photochemical smog, Formation of acid rain; adverse effects of acid rain; chemistry of photochemical smog; NO₂, HC and PAN.

Current developments in the subject.

Recommended Books:

1. Environmental Chemistry- G.S. Sodhi.
2. Environmental Chemistry- S. E.Mannhan
3. Fundamentals of soil science- Henry D. Futh.
4. Environmental Chemistry – A.K. De
5. Environmental Chemistry-A global perspective; G.W. Vantoon and S.J. Duffiy, Oxford Uni. Press, London.
6. Environmental Chemistry – R.C. Rasswell
7. Fundamentals of environmental chemistry –Stanley E. Manahan
8. Limnology – Wetzel
9. Photo chemistry and spectroscopy – J.P. Simmons
10. Fundamentals of photo chemistry – K.K. Rohatgi - Mukherjee.
11. Elements of environmental chemistry – H.V. Jadhav
12. Environmental chemistry – B.K. Sharma
13. Environmental chemistry – B.K. Sharma and H. Kaur
14. Environmental pollution analysis – S.M. Khopkar
15. Environmental chemical analysis – Lanin L. Marr, Malcom S.
16. Environmental Geology – Lundgran,
17. Environmental Geology – Barbara, Wim Brain, J.S. Stephen.
18. Environmental Chemistry – Kanan Krishnan.
19. Environmental Geology – Keller
20. Natural Hazards – Alexander
21. Geo Environmental Engineering – Reddic.
22. Environmental Chemistry – S.K. Banerjee.
23. Environmental Chemistry – J.W. Moore and E.A. Moore.
24. Destruction of hazards chemicals in the laboratory: G. Lunn and E.B. Sansone.
25. A text book of Environmental Chemistry and pollution control – S.S. Dara.
26. Environmental Chemistry – M. Satake, Do. S. Sethi, S.A. Eqbal.
27. Environmental and Man: The chemical environmental: J. Lenihan and W.W. Fletcher.

[Core theory course with 04 credits]**ENV- 403: Environmental Instrumentation & Analysis****Unit – I: Environmental sampling:**

Introduction, methods of sampling (selective, random, multiple), types of sampling (grab, integrated, composite), planning of sampling, protocol of sampling, selection of sampling sites, frequency of sampling, Sample preservation techniques.

Unit II: Air sampling Equipments: –

Tilak sampler / Anderson sampler for bio-monitoring, High volume air sampler (HVAS), Respirable Dust Sampler (RDS), Stack monitoring kit, Non-Dispersive Infrared Analyser (NDIR), Pulsed Fluorescent Analyzer, Chemiluminescent Analyzer,

Unit -III: Analytical Instrument:

Theory; principle; working and applications of following sampling instruments: pH meter; Conductometer, Fluorometer, Turbidometer, EC meter; DO meter; Nephelometer; Flame photometer; colorimeter; spectrophotometer (UV, IR, NMR, AAS) , Chromatography – Paper chromatography, TLC, GC, HPLC.

Unit – IV: Microbiological instruments and equipments:

Theory; principle; working and applications of equipments: Colony counter; autoclave; oven; incubator; laminar air flow; BOD incubator.

Unit -V: Accuracy and precision:

Advantages and disadvantages of instruments, Types of errors, Types of mistakes, Accuracy and precision, Trouble shooting of instruments,

Current developments in the subject.

Recommended Books:

1. Analytical chemistry – Gary D. Christian.
2. Mass spectrometry of pesticides and pollutants:
3. Hand book of analytical instruments –Khandpur R.S.
4. Chemistry for environmental engineering Sawyer, McLarty and Parkin.
5. Instrumentation methods for chemical analysis – B.K. Sharma.
6. Instrumentation methods for chemical analysis – Chatwal and Anand.
7. General microbiology – Power and Dagniwala
8. Microbiology – P.D. Sharma
9. Principals of biophysical chemistry- uppadahay –uppadahayand Nath
10. Analytical techniques –S.K.Sahani
11. Fundamental principle of bacteriology – P.C. Salle
12. Microbiology – Pelczar, M.S. Chand.
13. Introduction to Microbiolgy – Kappor and Touro
14. Microbiology – Maheswari and Dubey
15. Encyclopedia of environmental microbiology – P. Hotter
16. Industrial microbiology – K.C. Daa
17. Medical microbiology – Anant Narayana
18. Environmental Chemistry by S. C. Bhatya

[Elective theory course with 04 credits]
ENV- 421 A: Wildlife Conservation and Management

Unit I: Introduction to wildlife:

Definition and concept of wildlife; Value of wildlife – Ecological importance, Commercial value, Scientific value, Game value, Recreational value, and Ethical value; Status of wildlife – Abundant, threatened, endangered, greatly endangered, extinction-prone, extinct, and vermin; Wild life distribution in India - Himalayan mountain system (north east and north west), Peninsular India, Tropical rainforest region of India, Indian desert.

Unit- II: Threats and causes of loss of wildlife: Pollution, hunting, superstitions, over exploitation, developmental activities, mining, destruction of forest, habitat degradation, Trade in wildlife – history of trade in wildlife, trade in live animals, trade in wild life products, wildlife trade in India, CITES,

Unit III: Endangered Fauna of India: Causes of extinction of wild species, Endemic wild species from India, Endangered wild animals from India – Mammals, Birds, Reptiles, Amphibians,

Unit IV: Wildlife Conservation:

Need of wildlife conservation; Types conservation – In-situ conservation, Ex-situ conservation; Wild life conservation methods- Species specific conservation methods – Crocodile breeding project, Musk deer breeding project, Project Hangul, Project elephant, Project tiger etc; Community conservation methods - Protected areas such as Sanctuaries, National Parks, Biosphere Reserves, Zoos, Botanical gardens, & Gene banks;

Unit V: Wild life Management:

Need of wild life management; wildlife management principles; Wild life management techniques; Control hunting technique;

Ecosystem Management for Wildlife; Sanctuary and National Park management - management of forest fires, management of water resources, shelters, habitats, roads, corridors management for wild life.

Society and wildlife: Human –wild life conflicts, concept of wildlife-friendly communities, ecotourism, social issues, tribal communities and wildlife,

Current developments in the subject.

References:

1. Arms Karan, (1990), Environmental Science, Sounders College Publication, Philadelphia, pp. 74-99.
2. Botkin D. and Kellar E. (1995) Environmental Science, Earth as a living planet, John wiley and Sons, New York.
3. Biological Management and Conservation, by Usher.
4. Wild life Biology , by Dasman
5. Primates of South East Asia, by Roonwal
6. Forest Food and People, by F.A.O.
7. Ecological iversity ,by Pielou
8. Wildlife in India ,by V. B. Saharaia
9. Grass Ecology and Wildlife Management, by Duffey
10. The Book of Indian Birds, by Salim Ali
11. Environmental Conservatio , by Dasman
12. Man and His Environment, by Ward
13. Conservation of Animal Genetic Diversity, by F.A.O.
14. Animal Diversity, by. Hanson.
15. Jean-Christophe V. Craig Hilton-Taylor and S. N. Stuart (Eds), (2004) Wildlife in a changing world, IUCN, Switzerland.
16. Sahu T. R. (1998) Biodiversity-concept and concern efforts for its conservation, In: Perspectives in Environment, S.K.Agarwal (Chief Editor) APH Publication corp. New Delhi. Pp. 107-116.
17. Varma P. S. and Agarwal V. K. (1990) Principles of Ecology, S.Chand& Co. Pvt. Ltd., New Delhi.

[Elective theory course with 04 credits]
ENV- 421 B: Environmental Meteorology & Geosciences

Unit – I : Climate: Weather, Climate-Physiographic and geological homogeneity of India, Geo economic significance, Major climatic regions of the world based on latitude, Condition of climate. Classification of climates, Criteria for classification. Thornthwaites and Koppens classification.

Unit II:- Climate of India, Indian monsoon, The seasons, Mechanism of Monsoon, Forecast of Monsoon, Various seasons, distribution of rainfall, drought prone areas, flood prone areas. Climate change.
Causes and consequences of global warming, Ozone hole, El-Nino, droughts, Tropical cyclones and western disturbances, IPCC, UNFCCC, Kyoto protocol.

Unit – III : Meteorology: Scale of meteorology, Meteorological fundamentals, Primary and Secondary meteorological parameters, Temperature, Pressure, Wind, Humidity, Adiabatic lapse rate., Wind velocity, Wind roses, Turbulence, plume behavior, Weather forecasting, Establishing ambient and emission standards, Application of meteorological principles to transport and diffusion of pollutants.

Unit – IV: Environmental Geosciences: Fundamental concepts, Earth system and biosphere: Conservation of matter in various Geosphere, Lithosphere, Hydrosphere, Atmosphere and biosphere; Energy budget of the earth, Earth's thermal environment and seasons. Mineral structures and their compositions, Trace elements and their partitioning during mineral formation.

Unit – V: Earths Processes and Geological Hazards: Earth's processes, Concept to residence time and rates of natural cycles. Catastrophic geological hazards, Study of earthquakes, Volcanism, Floods, Landslides, Avalanche etc. Prediction and perception of hazards, adjustments to hazardous activities, Assessment of geological hazards and risks.

Current developments in the subject.

Recommended Books

1. **The Atmosphere : An Introduction to meteorology** :- Frederic K. Lutgen E.J.Tarback.
2. **Introduction to weather and climate** :-Trewartha
3. **Introduction to climatology for topics** :-Ayoade J.O.
4. **General Climatology** :- Critchfield H.J.
5. **Climatology ;Selected Application** :-Henry D.Foth
6. **Climatology: Fundamentals and Application**:-Mater J.R.
7. **Air pollution**:- V.P. Kudesia Pragati Prakashan Meerut
8. **Environmental Science** :- A study of interrelation ship E.D. Enger,B. E. Smith, 5th ed; WCB Publication.
9. **Fundamental of Ecology** :- E.P. Odum, Revised Edition 1995-96 Edition 2003.
- 10.**Forests of India** :- Champion and seth.
- 11.**A Manual of Air Quality Monitoring** :- NEERI Publication.
- 12.**Environment, Energy, Health, Planning, for Conservation**:-V. Vidyanath, Gyan Publication house, New Delhi.
- 13.**Meteorology of Air Pollution** :-R.S. Scores 1990 Ellis Harwood Pub.
- 14.**Fundamentals of Air Pollution**:- 2nd Ed. Arthur Co Stern Acad. Press 1984.
- 15.**Air Pollution** :- M.N. Rao, Mcgraw Hill 1993.
- 16.**General Meterology** :-Horace Robert Byers, Sc.D. 3rd Ed MCGRAW Hill Book Company new York Toronto, London.
- 17.**Enviromental Chemistry** :- A.K.De. Wiley Interscience.
- 18.**Environmental Chemical Analysis** :- Lain L. Marr, Malcom S. Cresser, international text book company, USA.
- 19.**Environmental Geology** : K.S Valdiya Indian Context Tata McGraw Hill Publication Co. New Delhi, 1987.
- 20.**Environmental Geology** : Barbara, Wim Brain, J.S. Stephan, C.P John Wiley & Sens. Inc
- 21.**Environmental Geology** : Lundegran, Lawarence Prentice Hall
- 22.**Env. Geology** : Keller
- 23.**Nuclear Hazards** : Alexander
- 24.**Geo Environmental Engineering** : Reddic, Tecnip books international, New Delhi.
25. **Text of the Kyoto Protocol** on www.unfccc.int

[Core course with 02 credits]**ENV-441 : Practical Paper – I**

1. Identification and classification of phytoplankton's from fresh water body (any 8).
2. Identification and classification of zooplankton's from fresh water body (any 8).
3. Quantitative analysis of zooplanktons and determination of percentage composition by Sedgwick Rafter cell method.
4. Quantitative analysis of phytoplankton's and determination of percentage composition Lacky's drop count method.
5. Estimation of biomass from grassland by harvest method.
6. Productivity study of grassland ecosystem by harvest method.
7. Determination of species area curve for deciding minimum size quadrat for plant community study.
8. Determination of relative density of species by using simulation.
9. Determination of relative frequency of species by using simulation.
10. Determination of relative abundance of species by using simulation.
11. Determination of chlorophyll content from plant species.
12. Determination of primary production of water body by harvest method.
13. To study the ecological adaptation in plants to aquatic habitat (Hydrophytes)
14. To study the ecological adaptation in plants to mesophytes.

[Core course with 02 credits]**ENV-442 : Practical Paper – II**

1. Collection techniques and sampling devices for gaseous pollutants
 - i) Absorption sampling, ii) Adsorption sampling, iii) Freeze out or condensation sampling, iv) Grab sampling
2. Study of micrometeorological equipments
3. Determination of relative humidity of air
4. Determination of atmospheric pressure by using barometer
5. Determination of wind speed by using anemometer.
6. Determination of wind direction by using wind vane
7. Determination of carbon dioxide from air by using Lungs Zecondroff apparatus
8. Determination of NO_x in ambient air by high volume sampler (HVS).
9. Measurement of SO_x by high volume sampler (HVS)
10. Measurement of SPM by using high volume sampler (HVS)
11. Measurement of RSPM by using Respirable Dust Sampler
12. Determination of atmospheric lead & other metals by using impinger techniques and AAS
13. Identification of minerals on the basis of physical properties (10 mineral specimens)
14. Identification of rocks: Igneous rock, sedimentary rock and metamorphic rocks

[Core course with 02 credits]**ENV- 443: Practical Paper – III**

1. Measurement of turbidity of turbid water samples by using Turbidometer.
2. Measurement of turbidity of water samples by using Nephelometer.
3. Measurement of conductivity of water samples by using Conductometer.
4. Estimation of phosphate content from sewage samples by using Spectrophotometer.
5. Estimation of ammonia content from sewage samples by Colorimeter.
6. Determination of pH of given water/soil samples by using pH meter.
7. Estimation of heavy metals (Copper and Mercury) from water samples by using Atomic absorption spectrophotometer.
8. Estimation of sodium content form water sample by using Flame photometer.
9. Estimation of potassium form water sample by using Flame photometer.
10. Determination of fluorescent compound by using Photofluorometer.
11. Separation of chlorophyll pigments of green leaf by using Thin layer chromatographic method.
12. Separation of a mixture of amino acid by using Paper chromatography.
13. Separation of geometric isomer compounds by using Column chromatography.
14. Determination of Dissolved oxygen content from water samples by using DO meter.

[Core course with 02 credits]**ENV-444 : Practical Paper – IV**

1. Determination of organic matter and organic carbon from soil by Walkle's – Black method.
2. Determination of total nitrogen from soil sample.
3. Determination of phosphate content from soil sample
4. Determination of soluble and leachable Calcium from soil sample
5. Determination of soluble and leachable Magnesium from soil sample
6. Determination of calcium carbonate from soil
7. Determination of nitrate (NO₃-N) content from soil sample
8. Estimation of permanent hardness from water sample.
9. Estimation of nitrate content from water sample.
10. Estimation of total acidity of water sample.
11. Estimation of total alkalinity of water samples
12. Determination of sulphate from water sample.
13. Determination of Dissolved oxygen from water samples by Winkler's method
14. Determination of free CO₂ from water sample.

(Academic Flexibility)

M.Sc. Environmental Science, Part I, Semester-II

[Core theory course with 04 credits]

ENV. – 404: Environmental Pollution Studies

Unit-I: Air pollution:

Concept of air pollution; natural and anthropogenic sources of air pollution; mobile and stationary sources of air pollution; sinks of atmospheric gases ;major air pollutants and their classification; air quality standards; primary and secondary air pollutants; types of air pollution-indoor air pollution, transport and dispersion of air pollutants; vehicular pollution, air pollution episodes and disasters; industrial pollution; monitoring of major air pollutants; effect of air pollutants- on plants, animals, human being and on materials; status of air pollution in India. Control measures

Unit- II: Water pollution:

sources of water pollution; major pollutants; types of water pollution – fresh water (rivers, streams, ponds, lakes, and underground water resources), marine water pollution (coastal and estuarine);water pollution episodes and disasters; consequences of water pollution; effect of water pollution; eutrophication; oil pollution; Thermal pollution; Effect of thermal pollution; Monitoring of water pollution; River pollution status in India; preventive measures.

Unit – III: Noise Pollution:

Physiological & psychological effects of noise pollution, vibration and impact isolation, Indian scenario of noise pollution, noise exposure levels and noise level, monitoring of noise, principal & function of noise meter, remedial measures, noise pollution control equipments-ear muffs, silencers, noise absorbing devices, noise standards, industrial noise control.

Unit - IV: Land pollution:

Causes and effects of soil pollution; major soil pollutants and sources; effect on plants and animals; nutrients in soil (NPK); domestic, municipal, industrial and agricultural wastes and their role in soil degradation; physico-chemical and biological methods of soil reclamation; effect of modern agro-technology on soil, soil salination; Soil conservation measures.

Unit- V: Radiation pollution:

concept of radiation pollution; major sources of radioactive pollutants; nuclear fusion and fission reactions, radioactive isotopes, units of radiation, effects of radioactive pollution, radioactive decay; interaction of radiation with matter; associated biological impacts and health hazards; use of nuclear weapons and their consequences, Impacts of radioactive fallout on health & environment, radioactive risk assessment and waste disposal practices.

Current developments in the subject.

Reference books:

1. Air pollution-M.N. Rao
2. Air pollution- A.C. Stern, Academic press Vol. I-X.
3. Guidelines of micro meteorological technique in air pollution studies – ISI (1978)
4. Air pollution-V.P. Kudesia.
5. Pollution control in process industry- S.P. Mahajan
6. Global air pollution- Brijman
7. Environmental pollution and management-L.Mohan
8. Environmental radioactivity –M.Eisendbud,academic press
9. Environmental analysis- P.R. Trivedy & Gurdeep Ray
- 10.Measurement of air pollutants-M. Katz Who (1969)
- 11.air pollution control-NEERI
- 12.Air pollution-Leadbetter Vol. I and II
- 13.Air pollution-Magill Holder and Ackely
- 14.Water pollution-A.K. Tripathi and S.N. Pande
- 15.Waste water engineering, treatment, disposal and reuse-Metcalf and Eddy.
- 16.water supply and sanitary engineering-R.C. Rangwala
- 17.Water pollution V.P. Kudesai
- 18.Soil pollution and soil organism-P.C. Mishra
- 19.Environmental radiation and thermal pollution and their control-G.R. Chhatwal, M.C Mehra, M.Satake, T.Katyal.
- 20.Environmental air pollution and its control-G.R. Chhatwal
- 21.Introduction to waste water treatment process-Ramalho R.S.

[Core theory course with 04 credits]**ENV- 405 : Environmental Microbiology & Biotechnology**

Unit-I: Introduction to environmental microbiology: History of microbiology, classification of microorganisms- prokaryotes & eukaryotes, microbial communities in nature – Microbiology of water, Microbiology of extreme environments, Microbiology of air, and Microbiology of soil.

Unit - II: Sterilization and Disease Control: Methods of sterilization, Culture media; Pure culture methods; Preservation and maintenance of microbial culture; Transmission of disease; Type of diseases- Bacterial diseases, Viral diseases, Airborne diseases, Food borne diseases, Water borne diseases, Soil borne diseases, Microbial Bio- deterioration; Microbial biodegradation; Use of microorganisms in paste control; Control of microorganism- Physical, Chemical, Antibiotic sensitivity.

Unit – III: Introduction to Environmental Biotechnology: Introduction, biotechnology vision, an interdisciplinary activity- (strain choice, mass culture, optimization of cell response, process operations, product recovery). Scope and importance, commercial potential, abatement of air pollution – (Biofilters, bioscrubbers, biotrickling filters), abatement of water pollution – (Biological treatment- oxygen demand, nutrients, alkalinity, pH & temperature, microorganisms), energy reactions – (aerobic conditions, anaerobic conditions).

Unit: - IV : Innovative applications of Environmental Biotechnology: Principles of bioremediation, factor responsible for bioremediation, bioremediation strategies- (In-situ bioremediations & Ex-situ bioremediation), Concept of Bioleaching and bio-absorption phytoremediation, metal phytoremediation, organic phytoremediation, bioremediation needs, biodegradation of organic waste – (lignin, hydrocarbons, agricultural waste, biopolymers), mycotoxins in biodeterioration, microorganism in pest control – (microbial pesticides, microbial herbicides), Vermiculture technology, Biofertilizers technology.

Unit: - V : Biosafety : Cartagena Protocol, Biosafety regulations-Scope of Biosafety regulatory frame work, Information required for biosafety assessment and decision Making, Development in Transgenic research and application in India, Concept of Genetic engineering and its applications, Gene- bank,

Current developments in the subject.

Recommended books:-

1. General microbiology-Power and Dagniwala
2. Microbiology-P.D. Sharma
3. Fundamental principle of bacteriology-P.C.Salle
4. Microbiology-Pelczar, M.S. Chand.
5. Introduction to Microbiology-Kappor and touro
6. Microbiology-Maheswari and Dubey
7. Encyclopedia of environmental microbiology-P. Hotter
8. Industrial microbiology-K.C. Daa
9. Medical microbiology-Anant Narayana
10. Chemical analysis-Kenneth A. Rubinson
11. Analytical chemistry-Gary D. Christian
12. Mass spectrometry of pesticides and pollutants
13. Hand book of analytical instruments-Khandpur R.S.
14. Chemistry for environmental engineering Swyer, McIarty and Parkin
15. Instrumentation methods for chemical analysis-B.K.sharma
16. Instrumentation method for chemical analysis-Chatwal and Anand.
17. Global environmental Biotechnology : D.L. Wise.
18. Methods in Biotechnology: Hans Peter Schmauder
19. Introduction to Environmental Biotechnology, A.K.Chatterji, Prentice Hall of India Pvt.Ltd, New Delhi.
20. Environmental Biotechnology-Basis Concepts and Applications Indu Shekhar Thakur I.K. International Pvt.Ltd.New Delhi.
21. Environmental Biotechnology S.K. Agawal.APH Publishing Corp, New Delhi.
22. Elements of Biotechnology, by Jogdand S.N., Himalaya Publishing House, New Delhi.
23. Biotechnology, by B.D.Singh, Kalyani Publishers, New Delhi.
24. Molecular Buiotechnology-Principles and Applications of Recombinant DNA, Glick and Pasternak. Panima Publishing Corporation, New Delhi.
25. A Text Book of Biotechnogy, R.C.Dubey, S.Chand & company Ltd., New Delhi.

[Core theory course with 04 credits]

ENV- 406: Natural Resources and Sustainable Development

Unit – I: Natural Resources and Environment:

Definition, Classification of natural resources, Renewable and Non-renewable resources, Use of natural resources and human development, Limitations of renewable and non-renewable resources, Exploitation of resource and degradation environment; Forest resources- forest products, use of forest product and deforestation, forest conservation, social forestry and agro forestry; Wildlife resource- causes of degradation of wildlife; Water resource- available fresh water resource, water use, water conservation, rain water harvesting; Fishery resource- declining fishery resource; Grazing lands- degradation of grassland,

Unit-II: Mineral Resources and Metals : Mineral resources- Important mineral resources, use of mineral resources, Environmental problems due to mining of minerals, cause of degrading mineral resources, Mineral resources and population, Oceans as new areas for exploration of mineral resources, Reclamation of mining areas, Environmental impact of overexploitation of mineral resources, Conservation of mineral resources;
Metals- exploitation of metallic ores, use of metals, smelters and environmental degradation, metal processing and environmental problems, Copper smelter and associated environmental problems;

Unit- III: Energy Resources:

Energy resources-conventional energy resources (fossil fuels), Energy use pattern, Environmental problems due to use of conventional energy resources; Non conventional energy resources- solar, wind, hydroelectric, tidal energy.

Unit-IV: Sustainable Development:

Basic objectives of sustainable development, Concept and strategies of sustainable development, Principles of sustainable development, Mechanism of sustainable development, Practices of sustainable development in India, Barriers to sustainable development.

Unit – V: Conservation of resources and sustainable development:

Policies and practices needed for sustainability, natural resource conservation practices for sustainability, Conservation of forest, water conservation, conservation of energy resources, recovery of resources, recycle of resources, reuse of resources, Industrial waste management through 3-R principles, Cleaner production.

Current developments in the subject.

Reference Books:-

1. Fundamental of Ecology-Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.
2. Concepts of Ecology (Fourth Edition) – Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Environment forest, ecology and man –Dixit R.K. Rastogi publication, New Delhi.
4. Living in the environmental – T.J.Miller
5. Natural resource conservation –Owen and Chiras
6. Encyclopedia Energy –I&II
7. Physical geography-Dasgupta
8. Environmental Science-Emger Smith
9. Environmental Science-Nebel
10. Elements of Biotechnology-P.K. Gupta, Rastorgi Publication, Meerut.
11. Sustainable development:- N.L. Gupta R.K. Gurjav [630.72(Gup/Gur)29.6858].
12. Sustainable development :- A.K. Shrivastave APH Publishing
13. Corporati 5, Ansavi Raod, Darya Ganj, New Delhi – 11002 [574.5
14. (SRI) 324429].
15. Water harvesting and sustainable supply in India :- R.N. Athavale Rawat Publication Jaipur and New Delhi. [628.168(ATH)318328].
16. Environment sustainable development :- V. Rajyalakshmi APH. Publishing corporation 5, Ansari. Road Darya Ganj New Delhi – 11002 [630.72 (RaJ) 322614].
17. Sustainable Economic development & low income economics (LIEs):- Raj Kumar Sen Kartic C. Roy Atlantic Publishing and distributors in collaboration with International institute for development studies (IIDS) Calcutta – 700 004 [3238.9(Sen/Roy) 323042].
18. Sustaining development Human Resources gender and environment :- R.N. Ghosh R. Gabby K.C. Roy Altantic publisher and distributors. New Delhi- 110002 [574.5 (GHO) 32 3041].
19. Environmental priorities in India and sustainable development :- TN Khoshoo
20. Resources and Human Well Being :- Archana Sharma.
21. Encyclopedia of energy resource management:- Priorities for 21st century (2 Vols), 2000, Sarup and Son's Publishers, New Delhi.
22. Environmental planning for rural development 2001: K.K. Singh, S. Ali Sarup and Son's publisher New Delhi.
23. Forest of India by Champion and Seth.
24. Environmental Science: A study of Interrelationship by E.D. Enger, & B.E. Smith WCB, Publication.
25. Fundamentals of Ecology by E.P. Odum (Revised edition)
26. Environment, Energy, Health, Planning for conservation By V.Vidyanath, Gnyan Publishing house, New Delhi.
27. Resource & Hum well-Being by Archana Sharma
28. Natural Resources by Oliver S. Owen.
29. Environmental priorities in India and Sustainable Development by T.N. Khoshro.
30. Environmental Geology by Barbara, Wim Brain, J.S. Stephen; John Wily & Sons Inc.
31. Environmental Biology by K.C. Agrawal.
32. Environmental & Ecology by P.D. Sharma.

[Elective theory course with 04 credits]
ENV- 422 A: Environmental Statistics & Modeling

Unit I: Fundamental Concepts in Environmental Statistics:

Statistical sampling, purpose of sampling, principles of sampling, merits of sampling, basics and types of samplings, simple random sampling, Stratified random sampling, Systematic sampling, Multistage sampling. Statistical methods for environmental systems, Primary and secondary data collection, methods of data representation, Measures of central tendency-mean and its types, median, mode, Measures of dispersion-Variance, Standard Deviation, Mean Deviation, Coefficient of Variation, range and quartile deviation, concept and types of skewness and kurtosis, moments.

Unit II: Probability

Concept of probability, addition and multiplication theorem of probability, conditional probability and unconditional probability, Simple problems on probability, Poisson and Binomial distribution.

Unit III: System Analysis and statistical testing:

Concept and types of hypothesis, null and alternative hypotheses, tests of hypothesis- t test, f test, z test and Chi-square tests, Variables of environmental interest, Concept of Correlation, its types and application in Environmental Science, Concept of Regression lines-x on y and y on x, regression analysis,

Unit IV: Computer applications:

Introduction to computer, computer organization, concept of software and hardware, functions, capabilities and limitations of computers, Use of computer in environmental Science, applications of Windows XP, MS Word, MS Excel, MS Power Point, Adobe Page Maker, Adobe Photoshop in environmental science, access of internet in environmental science, applications of computer in environmental science.

Unit V: Environmental Modeling:

Introduction to environment system analysis, modeling concept, linear, simple and multiple regression models, validation and forecasting, population growth model, Lotka Volterra model, Gaussian plume model, box model, point source stream pollution model, Cost-benefit analysis.

Current developments in the subject.

Reference Books:

1. Bodkin, Daniel D. (1995). Environmental Science- Earth As a Living Planet, John Wiley & Sons, New York.
2. Bodkin, Daniel D. (1995). Environmental Science- Earth As a Living Planet, John Wiley & Sons, New York.
3. Clark, C.W. (1976). Mathematical Bioeconomics: Optimal Management of Renewable Resources, John
4. Clark, C.W. (1976). Mathematical Bioeconomics: Optimal Management of Renewable Resources, John
5. Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer.
6. Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer.
7. Jorgensen, Environmental Modeling.
8. Ludwig, J.A. and Judwig, J.F. (1988). Statistical Ecology, Wiley and Sons, New York.
9. Ludwig, J.A. and Judwig, J.F. (1988). Statistical Ecology, Wiley and Sons, New York.
10. Pielou, E.C. (1997). An Introduction to Mathematical Ecology, John Wiley and Sons, New York.
11. Pielou, E.C. (1997). An Introduction to Mathematical Ecology, John Wiley and Sons, New York.
12. Ray, Devraj (1998). Development Economics, Oxford University Press, Oxford.
13. Ray, Devraj (1998). Development Economics, Oxford University Press, Oxford.
14. Snape and Dunn, Dynamics of Environmental Bioprocesses-modeling and simulation.
15. Sen, A. (1997). Poverty and Inequality, Oxford University Press, Oxford.
16. Sen, A. (1997). Poverty and Inequality, Oxford University Press, Oxford.
17. Smith, J. M. (1982). Evolution and the Theory of Games, Cambridge University Press, Cambridge.
18. Smith, J. M. (1982). Evolution and the Theory of Games, Cambridge University Press, Cambridge.

[Elective theory course with 04 credits]

ENV-422 B: Environmental Management Systems

Unit –I: Environmental Management: Environment Management system - Principles and elements, Concept and Scope, Systems and approach, Standards- International and National; Eco-mark, Environmental accounts and auditing, green funding and taxes, trade and Environmental Management.

Unit-II: Environmental Planning: Historical Background to know the adverse effects of lack of environmental planning, Importance and Measurement of baseline environmental data and their appraisal such as Water, Soil, Air, Natural assets, Demography, Heritage.

Unit-III: Environmental planning, Micro & Macro planning, rural & urban planning: Concept and need for environmental planning, levels of planning-micro & Macro Planning, National and regional Planning, Basic difference in rural and urban Planning, Demographic consideration, Dynamic, Available recourse planning, Gandhian concept of self relined Villages.

Unit- IV : Environment Management plan and ISO 14000 series: Scope of environmental management, Importance, Principle functions Of environment and enterprise, Objectives and need for training staff, Criteria for environment instruments, Project management, Production Management, Back ground and development of ISO 14000, OSHAS 18000.

Unit- V : Fair Environmental Practices: Total quality management and business environment; business ethics, Traditional trade and commerce practice and fair environment practice, Quality management and its impact of human society, Environmental initiative and national environmental policies; Environmental initiatives at national and global level; National environmental policies and its implementation structure; Role of NGO's and public participation in environment movements; International environmental initiatives-Stockholm's declaration, Rome report, Ramsar convention on wetlands, Vienna convention and Montreal protocol, Earth summit, Kyoto protocol,

Current developments in the subject.

Books Recommended:-

1. Natural Resource Conservation Owen and Chiras.
2. Environmental planning, policies and programs in India-K.D.Saxena.
3. Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing.
4. T V Ramchandra, "Management of Municipal Solid Waste" Capital Publishing.
5. Sustainable development (Vol.I & II): N.L.Gupta and K.K. Gurjar(ed); Rawat Publications.
6. Environmental management: G.N.Pandey; Vikas Publication House
7. Environmental management: H.M.Saxena: Rawat Publications.
8. Environmental Law and Policy in India: S.Divan & A.Rosencranz; oxford University Press.
9. Environmental management-Physio-ecological facets (Vol.I & II); Rai, Mohapatra & Goel (ed) Rawat Publications.
10. Environmental Management in India Vol.I & II: R.K. Sapru; Ashish Publishing House.

Env-445: Practical Paper – V: [Core course with 02 credits]

1. Calculation of mean, mode & median of data.
2. Calculation of standard deviation of data.
3. Calculation of co-efficient of variation of data.
4. Calculation of Karl Person's co-efficient of co-relation.
5. Calculation of regression equation Y on X & X on Y from the data.
6. Calculation of variance from data.
7. Calculation of standard error (SE) from data.
8. Problems on probability.
9. Problems on t-test.
10. Problems on Z-test.
11. Problems on f-test.
12. Problems on ANOVA.
13. Problems on chi-square test.
14. Application of Power point presentation in environmental data presentation.
15. Use of MS-Excel in environmental data analysis.

Note:- Scientific calculator is must for individual students during the theory and practical.

ENV-446 : Practical Paper – VI: [Core course with 02 credits]

1. Measurement of noise level from silent zones- educational institution, library and hospital.
2. Monitoring of noise pollution from:- a) Market and public Place b) industrial area and highway (heavy traffic zone)
3. Study of particulate matter from air by gravity technique and filtration technique.
4. Comparison study of dust deposition on plant leaves from the heavy traffic zone and non polluted site.
5. To study the effect of vehicular emission on chlorophyll content of plant.
6. To study the BOD of sewage sample.
7. To study the COD of sewage sample.
8. Determination of oil and grease from waste water collected from vehicle servicing center.
9. Nitrate content from sewage sample.
10. Phosphate content from sewage sample.
11. Qualitative detection of pesticides from contaminated soil.
12. To determination of soluble chloride content from saline soil.
13. Determination of total acidity and alkalinity of saline soil.

ENV- 447 : Practical paper-VII : [Core course with 02 credits]

1. To study the principle, construction, working and applications of equipments use in microbiological study (Hot air sterilizer, Incubator, Autoclave)
2. Preparation & Sterilization of culture media (Nutrient broth, Nutrient Agar, PDA)
3. Preparation of pure culture of selected micro organisms.
4. Collection & identification of air spores by Tilak air sampler
5. To study the motility of microorganism in a given sample by Hanging drop technique.
6. To study the micro organisms from given sample by staining technique.
7. Determination of fecal coli form bacteria qualitatively from sample.
8. Isolation & identification of food spoilage microbes from material.
9. Immobilization of bacterial sample.
10. Determination of Shannon & Wive diversity index to terrestrial animal community.
11. Determination of Margulif diversity index to terrestrial animal.
12. Calculation of Hills diversity number to terrestrial animals.
13. Determination of total population of species from ecosystem by organism removal method (simulation)
14. Total population of species by capture, recapture method. (simulation)

ENV- 448 : Practical paper-VIII: [Core course with 02 credits]

1. To study the cover and basal area study of tree species.
2. Determination of Important value index (IVI) for tree species & Identification its timber potential.
3. Profile study of natural pond/lake and manmade reservoirs.
4. Study of energy resources plants
5. To study the calorific value of biomass.
6. To study fresh water resources water quality parameters-pH, electric conductivity, total acidity, total alkalinity, dissolved oxygen, carbon dioxide TS, TDS and TSS.
7. Determination of moisture content and water holding capacity of soil.
8. Determination of residual chlorine content in treated drinking water.
9. To study the permanent hardness of treated drinking water.
10. Determination of total inorganic phosphorus content of soil.
11. To study Net Primary Productivity of water body (lake/pond) by Gaarder and Gran's method.
12. To study the Gross Primary Productivity of water resources (lake /pond) by Gaarder Gran's method.
13. To study the light intensity by sun shine recorder

(Academic Flexibility)

M.Sc. Environmental Science, Part II, Semester-III

[Core theory course with 04 credits]

ENV-501 : Pollution Control Technology

Unit-I: Air Pollution, its Control and Monitoring:

Air Pollutants, their effects and sources of origin, Dispersion of air pollutants into atmosphere, Control measures, Natural self cleaning properties of the environment, Dilution methods of controlling air pollution from stationary sources (Industries), Controlling air Pollution in automobile, equipments used to control air pollutants like SO₂, NO_x, CO, CO₂, PAN and Hydrocarbons, Methods used, Cyclone separators, Fabric filters, Electrostatic precipitators, Wet scrubbers, etc.

Unit – II: Sewage and Effluent Treatment in Industries:

Primary Treatment : Types of Screening, Design and disposal of screening, Grit removal basins, Detritus tanks, Design of parabolic grit chamber, Removal of oil and grease, Skimming tanks, Valuator's, Disposal of Skimming, Principle of sedimentation, Types and design of sedimentation tank.

Secondary treatment ; Principle and techniques of biological treatment, Oxidation and stabilization ponds, Aerated lagoons, Activated sludge process, Trickling filters, Techniques for sludge disposal thicker, digesters, conditioning and dewatering methods, Like sludge drying, Vacuum Filtration, Process filters, Centrifugation.

Unit – III: Advance Techniques used in Industrial Effluent Treatment:

Removal of nitrogen, Phosphorous, Total dissolves solid and suspended solids, Reuse and re cycle of wastewater, Operation and designing of ETP in various industries like ; Sugar, Paper mill, Dairy Textile, Food processing, Fertilizer and Petrochemical, Concept of Common effluent treatment plant (CETP), Designing for public owned treatment plant.

Unit-IV : Radiation and Noise pollution Control Techniques:

Types of radiation, Sources, Biological effects, Nuclear energy scenario, Control measures of beta radioactivity, Nuclear dilemma, Principle of Noise pollution, Decibel scale, Physiological and psychological effects of noise, Noise measurement, control criteria, Equipments used for measurement and Control measures in industries.

Unit-V: Solid Waste Management:

Types of solid waste biodegradable, Refractory and inorganic, Three 'R' Strategies, Industrial solid waste management, Urban and Agriculture, needs of solid waste management, Compaction, Dewatering, Briquette, Size reduction, Separations of inorganic and organic i.e. Removal of metals, Loading, Collection, Storage and transportation, Disposal and reuse methods for solid waste, Source of raw material i.e. fly ash, Light weight bricks and compositing, Recycling and incineration, Pyrolysis, Biogas generation.

Current developments in subject.

Reference Books:

1. Michael L. McKinney and Robert M. Schoch, 2003, Environmental Science-systems and solutions, Jones and Bartlett Pub., Boston.
2. Peavy, H.S., 1985, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
3. Peavy, H.S., Rowe D. R. and Tchobanoglous G., 1985, Environmental Engineering, Tata McGraw-Hill International Ed., New York.
4. Purohit S.S. and Ranjan R., 2003, Ecology, Environment and Pollution, Agrobios, Jodhpur.
5. Raju B.S.N., 1997, Fundamentals of Air Pollution, Oxford & IBH Pub. Co.Pvt.Ltd., New Delhi.
6. Rao M.N. and Rao H.V.N. 1989, Air Pollution, Tata McGraw-Hill Pub. Co.Ltd., New Delhi.
7. Rao C.S., 1991, Environmental Pollution Control Engineering, Willey Eastern Ltd., New Delhi.
8. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
9. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
10. Michael L. McKinney and Robert M. Schoch, 2003, Environmental Science-systems and solutions, Jones and Bartlett Pub., Boston.
11. Peavy, H.S., 1985, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
12. Peavy, H.S., Rowe D. R. and Tchobanoglous G., 1985, Environmental Engineering, Tata McGraw-Hill International Ed., New York.
13. Purohit S.S. and Ranjan R., 2003, Ecology, Environment and Pollution, Agrobios, Jodhpur.
14. Raju B.S.N., 1997, Fundamentals of Air Pollution, Oxford & IBH Pub. Co.Pvt.Ltd., New Delhi.
15. Rao M.N. and Rao H.V.N. 1989, Air Pollution, Tata McGraw-Hill Pub. Co.Ltd., New Delhi.
16. Rao C.S., 1991, Environmental Pollution Control Engineering, Willey Eastern Ltd., New Delhi.
17. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
18. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
19. Michael L. McKinney and Robert M. Schoch, 2003, Environmental Science-systems and solutions, Jones and Bartlett Pub., Boston.
20. Peavy, H.S., 1985, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
21. Peavy, H.S., Rowe D. R. and Tchobanoglous G., 1985, Environmental Engineering, Tata McGraw-Hill International Ed., New York.
22. Purohit S.S. and Ranjan R., 2003, Ecology, Environment and Pollution, Agrobios, Jodhpur.

23. Raju B.S.N., 1997, Fundamentals of Air Pollution, Oxford & IBH Pub. Co.Pvt.Ltd., New Delhi.
24. Rao M.N. and Rao H.V.N. 1989, Air Pollution, Tata McGraw-Hill Pub. Co.Ltd., New Delhi.
25. Rao C.S., 1991, Environmental Pollution Control Engineering, Willey Eastern Ltd., New Delhi.
26. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
27. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
28. Water pollution: A.K. Tripathi and S.N. Pandey
29. Waste water engineering treatment, disposal and resue – Metcalf and Eddy.
30. Water supply and sanitary engineering – R.C. Rangawala.
31. Introduction to waste water treatment process – Ramalho R.S.
32. Water pollution – V.P. Kudesia
33. Eco-technology for pollution – R.K. Trivedi and Arvind Kumar
34. Environmental engineering control and environmental management – Arcadio, P. Sincero and Gregoria.
35. Water and wastewater technology – Mark J. Hammer.
36. Integrated Solid waste Management: George Techbanoglow Theisen and Vigil.
37. Environmental Pollution and Engineering : C. S. Rao
38. A. D. Bhide and B. B. Sunderson, Solid Waste Management in developed Countries, INSDOC, New Delhi (1983).
39. Sinha R. K., Sinha A. K., Saxena V. S., A book on Waste Management INA, Shri Publishers, Jaipur (2000).

[Core theory course with 04 credits]
ENV – 502: Industrial Safety Management

Unit I: Industrial Safety philosophy:

Concept of safety, philosophy of safety, safety psychology, accident caution and prevention, statistics of safety – accident cost to injured person and management, measurement of safety performance, accident classification, performance of accident statistics; appraisal, analysis, inspection and control techniques – safety appraisal analysis and control technique,

Unit II: plant safety inspection, accident investigation - analysis and reporting; Accidents sequence theory, causes of accident, accident prevention and control techniques, effect of industrial accidents, job safety analysis and investigation of accident; occupational injuries, role safety committee, safety awareness programme, total loss concept control, Legal and social consideration of industrial safety : concept, essentials of safety audit, audit procedure, audit benefits.

Unit III: Safety Management: concept and definition, safety organization, safety department and safety programmes, safety education and training, plant safety rules and procedures; safe design and layout of plant – planning and safety engineering approach, site selection, layout design of plant of building; machine grading; Safety audit.

Unit IV: Housekeeping: good housekeeping – meaning and usefulness, management of housekeeping, accidents due to poor housekeeping, use of colour as aid for good housekeeping, housekeeping contest, inspection and checklist, housekeeping of specific industries; lighting and colour; ventilation and temperature; fire safety; electric safety; material handling; working at heights and depths;

Unit V: Personal protective equipments; safety in engineering industry; safety in textile industry; safety in chemical industry; occupational health and hygiene; health hazards in specific industries; first aid – general principle, industrial injuries in first air, electrical injuries, artificial respiration, burns; on-site and off-site emergency plane.

Current developments in subject

Reference Books

1. Frank Lees Book on loss prevention in process industry, vol. 1 & 2.
2. Industrial safety / safety management – K.G. Mistry
3. Safety Management – Grimandi and siemens.
4. Safety supervision – Peterson
5. Eleventh edition of NSC, USA
6. IS 14489 On Safety Audit
7. Factories Act 1948
8. Environmental Protection & Law – H. V. Jadhav & V. M. Bhosale
9. Law Science & Environment – R. P. Ananad
10. Instrumental Methods of chemical analysis – Willard Merrit Dcan.
11. International Environmental Policy emergence and Dimension by L. K. Caldwell 1990.
12. Safety, Security and Risk management: UK Singh and JM Dewan, A.P.H. Publishing Corporation, New Delhi – 110002.

[Core theory course with 04 credits]**ENV – 503: Environmental Toxicology & Biodiversity**

UNIT- I : Scope and concept of toxicology and eco-toxicology, Branches of toxicology (clinical, environmental, economic, forensic, industrial, genetic, systemic and behavioral); Environmental toxicology- environmental toxicants (toxicants contaminating food, toxicant present in atmosphere, toxicants present in hydrosphere); Environmental carcinogens, calibration of dose response curve, lethal dose, LC₅₀ and safe concentration, acute toxicity, chronic toxicity; Neurotoxicity, carcinogenicity and mutagenicity.

UNIT-II:

Classification of toxicants- natural and synthetic, Pesticides- classification, mode of action of pesticides; Recent trends in the use of pesticides; Plant toxins- Aflatoxins, ergots, pyrethroids; Heavy metal toxicants and their toxicity (lead, arsenic, mercury, cadmium and chromium, copper; Zink); Xenobiotic components- Factors affecting metabolism of xenobiotics; Exposure of toxicants- Routes and sites of exposure, types of exposure (acute and chronic), Dose- response relationship, Translocation of toxicants (absorption, distribution and extraction); Mechanism of action of toxicants; Selective toxicity; bioaccumulation of toxicants.

UNIT-III:

Bio-assay techniques; protocol of toxicity evaluation of toxicants, Tests for assessing carcinogenicity and mutatoxicity of toxic compounds, TLC techniques for determination of toxicants in water and vegetables samples

Unit-IV: Introduction to biodiversity; Types of biodiversity; Importance of biodiversity; value of biodiversity; alpha and beta biodiversity; Genetic diversity; causes of loss of biodiversity; measurements of biodiversity; listing of threatened biodiversity;

Unit-V: Need of conservation; obstacle to biodiversity conservation; methods of biodiversity conservation – in-situ conservation (sanctuaries, national parks & biosphere reserve); Ex-situ (zoo, botanical gardens, gene/germ plasma banks); Biodiversity legislation; National policy and action plan; Diversity Act 2002;

Current developments in subject

Reference Book

1. Principles of Environmental toxicology:-Ian C.Shaw and John Chadwick, Taylor and Francies.
2. Environmental Toxicology and Chemistry:-Donald G. Crosfy 1998
3. Text book of modern Toxicology:- David A. Wright and Pamela Welbourn Cambridge University Press 2002.Ernest Hodgsen and patricia E.levi Appleton and Lange Stamford etc U.S.A.1995.
4. Basic Toxicology:- Frank C. Lu, Homisphere publishing Corporation, New York, Washington 1993.
5. Essentials of Toxicology: - Loomis TA, Leae Fabiger.
6. Toxicology:-Hayes.
7. Principles of toxicology:-Cassarett and Doulls.
8. Biodiversity and environment – S.K. Agrawal
9. The Biological Diversity Act. 2002 and Biological diversity rules 2004-National Biodiversity Authority India. 475, 9th South cross stree, Kalpalocwar Nagar, Neelangarai, Chennai-600041
10. Biodiversity measurement and estimation D.L. Hawks
11. Biodiversity conservation-Global agreements and national concerns. RAMSAR sites CBD, Quarantine, Regulation, National Forestry policy, Biodiversity Act, Wild life protection Act.

[Elective theory course with 04 credits]
ENV – 521 A : Environmental Legislation & Polices

Unit- I: Environmental Laws:

General: Need of laws, Importance of environmental legislation, National Environmental Policy Act (NEPA), History of environmental laws in India- Laws about environment in historic period, Laws about environmental component adopted during British rule – The Indian Forest Act, 1927.

Unit-II: Environment: -Environmental (Protection) Act, 1986; Environmental (Protection) Rules, 1986; The Hazardous Waste (Management and Handling) Rule, 1989; The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996; The Bio-Medical Waste (Management and Handling) Rules, 1998; The Recycled Plastics Manufacture and Usage Rules, 1999; The Noise Pollution (Regulation and Control) Rules, 2000; The Municipal Solid Wastes (Management and Handling) Rules, 2000. CRZ Notification of 2011.

Unit- III:

A) Air: - The Air (Prevention and Control of Pollution) Act, 1981; The Air (Prevention and Control) Rules, 1982.

B) Water: - The Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Rules, 1975

C) Forest: - The Forest Conservation Act, 1980; The Forest (Conservation); Rules, 1981; The National Forest Policy, 1988.

D) Wildlife: - The Wildlife (Protection) Act, 1972; The Wildlife (Protection) Rules, 1995; The Recognition of Zoo, Rules, 1992.

Land acquisition Act, Land Acquisition R&R bill, state laws / Policies on R&R

Unit IV: Environmental policy:

Government policies in the protection and development of environment – environmental considerations in economic planning and development in India. Public policy strategies in pollution control. Environmental policy resolution. NCEP and district environmental status report preparation.

Environmental forest clearance processes, National Green Tribunals (NGT). Concept of Green building , criterial and coponent in green building design.

Unit V:

A) Stockholm Conference; Earth Summit, Johansburg Summit, Rio Declaration, Agenda 21; United Nations Environment Programme (UNEP), International Union For Conservation of Nature and Natural Resources (IUCN), World Water Council (WWC), World Health Organization (WHO), World Wide Fund for Nature (WWF).IPCC.

Current developments in subject

Reference Books

1. Hand Book of Env. Laws, Acts, Rules, Guidelines, Compliance and Standard Vol. 1 & 2: R. K. Trivedy Environmental Edition: 1st 1996.
2. Pollution control Acts, Rules and notifications issued there under: Central Pollution Control Board April. 1995.
3. Environmental Protection and the Laws: C. N. Mehta, 1991.
4. Legal aspects of Environmental Pollution and its Management: Ed. S. M. Ali, 1992.
5. International Environmental Policy Emergence and Dimensions: by L. K. Caldwell 1990.
6. Lal's Commentevis on water, Air pollution laws along with the environmental (Protection) Act and rules 1986, 3rd Rd. 1992: Law Publisher India.
7. Universal Environment and Pollution law manual: S. K. Mohanty 1998.
8. Pares Distn. Environmental Laws in India: (Deep, Lated Edn).
9. Environmental Problems, protection and control Vol I & Vol II Ed: Arun Kumar.

[Elective theory course with 04 credits]
ENV- 521 B: Ecological Foot Prints & Carbon Sequestration

Unit I: Carbon emission and Global Issues.

Nature of environmental problems, intensity, general causes, and impacts of global, regional and local environmental problems, population explosion and carbon emission trends, carbon emission and global warming, carbon emission and climate change, ozone layer depletion, acid rain, loss of biodiversity, environmental degradation, pollution of air, water and soil, mitigation and remedial measures.

Unit II: Carbon footprints and Sustainability

Environmental ethics, consumerism and carbon emission trends, comparison of rural and urban consumerism, sources of carbon emission, carbon footprints and ecological stability India's ecological footprint, concept of sustainable human society, carbon capturing for sustainable future.

Unit III: Carbon Sequestrations

Concept of carbon sequestration in plants, animals and soil, carbon sequestration in food chain, food web, carbon storage in plant and soil, carbon sequestration as greenhouse mitigation policy, role of trees, vegetation and forest in carbon sequestration, monitoring and measurement of wood and soil carbon.

Unit IV: Carbon credits:

Pattern of energy use, energy technologies and environmental impacts, need of carbon trading, Concept and theme of Kyoto protocol, role of international agencies, obligation on nations for carbon emission reduction, Kyoto declaration, Economics of carbon sequestration, legal and institutional issues, carbon credit evaluation mechanics, carbon credit-trading and tax.

Unit V: Energy Conservation and Carbon Trading:

Domestic energy needs, social energy utilization pattern, energy use and carbon emission in industrial and commercial sectors, energy utilization pattern of global, national and local levels, methods for the conservation of energy, Concept of carbon trading, Carbon marketing potential, carbon credits and agriculture, Scope of carbon trading in India.

Current developments in subject

Reference Books:

1. IPCC (Intergovernmental Panel on Climate Change) 2006. Guidelines for national greenhouse gas inventories. Vol. 4, Agriculture, Forestry and other land use (AFLOLU). Institute for Global Environmental strategies, Hayama, Japan.
2. <http://www.carbonfootprint.com>
3. [http://www.footprintnetwork.org/en/index.php/GFN/page/carbon footprint](http://www.footprintnetwork.org/en/index.php/GFN/page/carbon_footprint)
4. [http://www.coeearth.org/article/Carbon footprint](http://www.coeearth.org/article/Carbon%20footprint)
5. Arnaud Brohé, Nick Eyre and Nicholas Howarth Carbon Markets An International Business Guide,
6. Brian J McPherson; E T Sundquist, 2009. A book on Carbon sequestration and its role in global carbon cycle, Washington, DC : American Geophysical Union ; published under the aegis of the AGU Books Board.
7. <http://envfor.nic.in/cc/cdm/publications.htm>
8. S.P. Sukhatme, Solar energy McGrawhill Publication.
9. S. H. Pawar, C. D. Lokhande, R. N. Patil, 1988. Solar energy and Rural Development, Shivaji University, Kolhapur.
10. Chawla, O.P. Advances in Biogas Technology, ICAR Pub. New Delhi.
11. Rai, G.D. Non-renewable Energy Resources, Khanna Pub., New Delhi.

[Elective Service theory course with 04 credits]
ENV-522: Climate Change & Global Environmental Issues

Unit – I: Climate Change:-

Climate change- introduction, concept and phenomenon; Climate change and its impact on agriculture, its impact on agricultural biodiversity, climate change and emerging of new kinds of diseases and epidemics; Human health problems , climate change and its impact on hydrological cycle - rainfall, icefall, surface water resources; Climate change and oceanic environment; IPCC reports ; Energy policies in Asia in light of climate change; Strategies to handle green house warming - China's stand; Reply of Malaysia to Global Climate change; India's action plan on climate change.

Unit – II: Global and local environmental issues:

Global environmental problems- global warming concept and considerations; green house emission rate; ozone layer depletion; Cycles of global environment change; Scientific evidences of greenhouse effect or to global warming ; Effect of Global warming : atmospheric gases and their impacts on ionosphere, Meteorology and dispersion of atmospheric gases, Green house effects current status, polar ice caps and snow melting due to temperature fluctuation, Health and hygiene considerations due to global warming; Global warming and other related environmental problems with respect to aquaculture,

Unit – III : Environmental and developmental priorities in India

Developmental priorities in India, Pre independence and post independence development, Industrialization, Green revolution, Urbanization, developmental priorities vs. environmental priorities, resource depletion and degradation due to improper priorities such as water, soil, forest etc in India.

Unit – IV : Global environmental Movements and controversies:

Environmental movements - Environmental movements and peoples responses; Green peace, world watch Institute, wetland international etc. Indian environmental movements and initiatives Chipko, Apico, Narmada Bachao Andolan, Save western Ghats, Environmental Controversies : social political and economic issues in the controversies, Narmada Project, Almatti dam, Sarda Sarovar project, Tehri dam, Koyna dam, MIC gas tragedy, Chernobyl tragedy, Mahtura Refinery case, Silent valley, Rehabilitation and settlement issues, government policies and social awareness for the protection of environment. Reclamation of alkaline and saline soils, Interstate river water disputes.

Unit – V : Natural Man made Hazards: :

Flooding, Nature and frequency of flooding, Impacts of flood hazard; urbanization and flooding; flood mitigation methods; land slide – causes and consequences; human land use and landslides; prevention and control of land sliding, Coastal hazards; tropical elegance and tsunamis; coastal erosion; sea

level changes and its impact on coastal areas. Earthquakes; causes, intensity and magnitude of earthquakes; causes; geographic distribution of earthquake zones, seismic waves, travel time and location of epicenter; natures of destruction; ground subsidence; protection from earthquake hazards; volcanism; nature and causes of volcanism, volcanism and climate. Social and economic impact of natural disasters;
Man made Hazards :-Industrial accidents; causes and effects of hazardous waste, chemical waste and their disposal and control, oil spills-causes, impacts and control, manmade hazards; forest fire, industrial fires and control; environmental degradation due to wars.

Reference Books :

1. Coastal Zone Management by Dr. Ramakrishnan Korakandy.
2. Environment Security and Tourism Development in South Asia by V.C. Pandey
3. Environment and its Global Implications by Gopal Bhargava.
4. Indian Vistas of Environment by Chittabrata Palit and Mahua Sarkar.
5. The Immanent Disaster A vision on Climate change by Sampooran Singh
6. Natural Resources of Himalaya by K.S.Gupta/
7. Fly Ash Amendment and plant Growth by Dr. S.M. Mohan
8. Environmental Education by Archana Tomar
9. Disaster management by S.Narayan
10. Biodiversity and Ecosystem Conservation by Ashish Dutta
11. Corporate governance for sustainable environment by Ramesh Chandra and Ritu Aneja
12. Global warming and climate changes transparency and accountability ed by Gopal Bhargava.
13. Energy and environment in india by K.C.Gupta

ENV-541: Practical paper-IX [Core course with 02 credits]

1. Solid and liquid hazardous waste collection from different sources (industries).
2. To study and list the laboratory safety and industrial safety principles and practices.
3. To study the impact of solid hazardous waste (toxic substance) on germination and growth of crop plants.
4. To study the dissolve oxygen content from industrial waste water by modified Wrinkler's method
5. To study the BOD of waste water produced from sugar industry.
6. To study the COD of sugar industry waste water.
7. Determination of iron content from industrial waste water sample.
8. Determination of lead (Pb) content from wastewater sample by using spectrophotometer method/ AAS.
9. Determination of Mercury (Hg) from industrial waste water sample.
10. Determination of Zinc (Zn) from industrial waste water sample by AAS or by spectrometric / titrometric method.
11. Estimation of Nickel from industrial effluent by titrometric/ spectrometric or by AAS method.
12. Estimation of cooper from industrial effluent by titrometric/ spectrometric or by AAS method.
13. Estimation of Aluminum from industrial effluent by titrometric/ spectrometric or by AAS method.

ENV- 542 : Practical paper-X [Core course with 02 credits]

1. To determine MLSS, MLVSS and Sludge Volume Index (SVI) of industrial waste water.
2. To study the rate of settling of suspended material form waste water.
3. Determination of residual chlorine content from chlorinated water samples.
4. Determination of available chlorine from bleaching powder.
5. Determination of sodium hydroxide content from caustic soda.
6. Determination of sulphates from caustic soda.
7. Determination of moisture content from lime powder.
8. Determination of chlorides from caustic soda.
9. Field visit for the observation of ETP / Hazardous Waste Disposal site.
10. To study the design, working and problems of primary clarifier.
11. To study the design, working and problems of trickling filters.
12. To study the design, working and problems of septic tank.
13. Problems on calculation of capacity of aeration tank in activated sludge process.

ENV- 543: Practical paper-XI [Core course with 02 credits]

1. To study the common test animals of toxicity assessment and their acclimatization.
2. To study the dose response curve of toxicant with respect to different concentration and exposure time in same size test animals.
3. To study the dose response curve of toxicants with respect to different body size and exposure time in same concentration of toxicant.
4. Determination of lethal dose (LD) of toxicant (pesticides / heavy metals compounds) in test animal (Channa fish) in 24 hours.
5. Determination of LC_{10} , LC_{50} & LC_{90} of toxicant (pesticide/heavy metal compound) in aquatic animal (fish/snail) for 24, 48, 72 & 96 hours exposure.
6. Determination of lethal dose of toxicant (pesticide / heavy metals) in test animal from LC_{50} values.
7. Determination of safe concentration of toxicant (pesticide/heavy metals) in test animal from LC_{50} values.
8. Toxicity assessment of solid/powdered form of toxicant in solid-solid mixture and determination of LC_{50} value for 24 hours in insects.
9. To study the effect of acute exposure of toxicant on oxygen consumption in aquatic test animal.
10. To study the chronic effect of toxicant on carbohydrate/ protein content of tissue in test animal.
11. Qualitative detection of pesticides in tissue of pesticide exposed test animal by TLC method.
12. To study the bioaccumulation of toxicant in test species (plant/animal).

ENV- 544 : Practical paper-XII [Core course with 02 credits]

1. Qualitative detection of toxic substance in waste water by T.L.C.
2. Immobilization of cultured bacterial sample
3. To study the potential plants for phytoremediation and their collection
4. The reduction of TS and TSS level from waste water by using phytoremediation technique.
5. The reduction of COD of waste water by using phytoremediation technique
6. Immobilization of yeast cells/ algae / bacterial culture.
7. Determination of total organic carbon present in compost prepared from solid waste.
8. Preparation of vermicompost from garden waste and municipal solid waste.
9. To study the pH & moisture of vermicompost prepared from solid waste.
10. The reduction of heavy metal pollutant level (copper ions) from industrial waste water by using bacterial culture.
11. To study the bioindicators species from aquatic ecosystem indicating water pollution due to specific sources.
12. Colour removal from waste water by using activated carbon filters / fluidized bed.

(Academic Flexibility)
M.Sc. Environmental Science, Part II, Semester-IV
[Core theory course with 04 credits]
ENV -504: Remote Sensing & GIS

Unit I: Remote sensing:

Introduction and scope of remote sensing, Fundamentals principles- Electromagnetic spectrum, Transmission, Absorption, Reflection, Energy interaction with earth surface and atmosphere; Photography- Working principle, Cameras-Types, Films, Aerial photography- Types of aerial photographs (Vertical and oblique photography), Geometry of Aerial photograph, Scale of Aerial Photographs, Stereoscopy- Stereoscope, stereoscopic photograph, Parallax, Mapping from photograph; Concepts of remote sensing, Platforms and Sensors (Visible and Near IR, Thermal- IR, Microwave and Sonic Sensors) ; active and passive remote sensing,

Unit II: Satellite Remote sensing :

Introduction, Remote Sensing Satellites- Meteorological Remote Sensing Satellite (Polar and Geostationary Satellites), Non Meteorological RS Satellites (Landsat, Spot, IRS, ERS, JERS, IKONOS Quick Bird, TOPEX), Resolution (Spectral and Spatal and Frequence of Coverage) ; Satellite data products and selection of satellite data; Data Reception Archiving and distribution;

Unit III: Lasers and Airborn Remote Sensing System-Lidar system and Laser Flurosensing; Active Microwave Instruments-The Altimeter and Scatterometer ; Multispectral Images; Interpretation of Remote Sensing Data- Identification of Earth Surface Features, Digital Image Processing- Image Structure, Image Enhancement , Band combination, Image classification.

Unit IV: Geographic information system: Definition, principles and scope of GIS, capabilities and advantages of GIS, use of GIS in spatial analysis, graphics output, Raster and vector data structure, Introduction to GIS and software packages, GIS software's application in environmental management and EIA studies, Digital Terrain Model, data base concepts for GIS data quality, data classification multivariate analysis, Use of image processing and GIS in environmental studies, GIS and economic models as information system for sustainable development, Geographical positioning system – application of GPS,

Unit V: Application of aerial photographs; Role of remote sensing in studying deforestation, soil erosion, flood mapping, flood damage assessment, drought assessment, and water shed management

Current developments in subject

Reference Books

1. Remote Sensing and Image Interpretation:-Tomas M.Lillesand and Ralph W.Keifer john Wiley and sons Inc.New Yark.
2. Introduction to Remote sensing:-James B. Campbell, Tylor and Franeis Ltd.Londan.
3. Fundamentals of GISN:-Michael N.Demers..
4. Remote Sensing application in applied geosciences:-Sumitra Mukherjee, Milton Book Company.
5. Environmental Geography:-H.M Saxena, Milton Book Company.
6. Principles of Photogeology:-Singh.
7. Principles of Remote Sensing:-Currain.
8. Fundamentals of Photogeology:-S.N.Pandey.
9. PC Software made simple:-Taxali.
- 10.Illustrated lotus 1-2-3:-by Muller.
- 11.Principles of Remote Sensing:-A.N.Gatel and S.Singh, Scientific Publishers (India). Jodhpur (1999Edition).
- 12.Remote Sensing for Environment and Forest Management:-A.Mehrotra and R.K.Suri. Indus Publishing Co.New.Dehli(1994 Edition)
- 13.Remote sensing for large wildfires:-E.Chuvienco, Springer, New York (1999 Edition).
- 14.Remote Sensing in Geoscience:-Tripathi N.K.
- 15.Remote sensing and GIS for site characterization;-Application and standard:-Singhroy, Technip Books International New Delhi.
- 16.Environmental Remote Sensing:-Saumirta Mukherjee.

[Core theory course with 04 credits]
ENV-505 : EIA & Environmental Audit

Unit I: Introduction: concept of EIA, scope and objectives of EIA; Nexus between development and environment, origin and development of EIA. Measurement of impact-physical, social, economical, natural; concept of significant effect; short term versus long term effect; skip relation of EIA to sustainable development.

Unit II: Environmental impact Assessment Methods:

Screening process, TOR, data collection, protocol for evaluation of impacts, pollution load calculation, methods of impact analysis :- Impact identification prediction, evaluation monitoring and mitigation measures, Public participation in environmental decision making, Assessment of various categories of EIA-rapid, comprehensive, regional and strategic EIA. Various components of EIA, Impact interpretation, various impact analysis methods-checklist, overly, matrix, and Adhoc methods.

Unit III: Assessment of Impact

Overview of EIA notification, 2006 and amendments, Evaluation of proposed actions and determination of impact importance, Development of value functions and scoping of EIA methodologies, preparation and writing of EIA/EIS, Review of procedure, practices and guidelines for EIA in India. Role of EIS in EIA –Baseline study, risk assessment, risk management, mitigation measures and comparison of alternatives Impact analysis with respect to air and water quality, noise, energy, vegetation and wild life and social and economic issues, Public participation in EIA.

Unit IV: Case Studies of EIA

EMP for a particular sector like, urbanization, mining, industrial [cement, Pharmaceutical, distillery etc]. Thermal power plants, hydropower, Road and highway projects etc.

Unit V Environmental Audit

Introduction ; Scope , Applicability and Objectives of Environmental Audit; Notification and Guidelines for Environmental Audit; Procedure of Environmental auditing (Water, Raw Materials and Energy balance; Hazardous waste Audit, Safety Audit); Designing and implementation of audit tools; pre audit activities; on site activities; post audit activities; Environmental statement; benefits of environmental audit; EA scenario in India – submission of Environmental Audit report in MOEF format – form VB; Environmental performance evaluation;

Current developments in subject

Reference Books

1. Environmental Impact Assessment: A. Eillpin.
2. Environmental Impact Assessment and Management: H. Kumar (1998).
3. Environmental Impact Assessment of Tehri Dam: V. Govardhan.
4. Practical guide to Environmental Impact Assessment: Belly Bowers and Marriott (1977).
5. Environmental Impact Assessment: A. K. Shrivastava APH Publication 2003.
6. Law of Intellectual Property: Dr. S. R. Mysani Asia Law House (2nd Edition) Law Book Sellers, Publishers and Distributors Hyderabad.
7. Environmental Impact Assessment, L. W. Canter, McGraw Hill publication, New Delhi.
8. Proceedings Indo-US workshop on environment impact analysis and assessment (1980) NEERI, Nagpur.
9. Environment & Social impact assessment, Vlcany, F., Bronsetin DA (1995), John Wiley & Sons, New York.
10. EIA – A Biography. B. D. Clark, B. D. Bissel, P. Watheam.
11. Second world congress on engineering and environment 1985, Institution of engineers.

[Core theory course with 04 credits]
Env-506 : hazardous Waste Management

Unit- I : Basic Aspects of Hazardous Waste Management :- Introduction - Hazardous waste ; concerns of hazardous wastes ; Aspects of control system for hazardous wastes (Quantities of hazardous waste, problem in controlling hazardous wastes, specific problems of developing, countries socio-political reasons.) Types of Hazardous wastes.

Unit- II ; Classification of Hazardous Wastes :- Identification and classification of Hazardous wastes; classification scheme - Notation of health / Ecological concerns; Inorganic wastes; oily wastes; organic wastes; putrescible organic wastes; High volume / low hazard wastes; Miscellaneous wastes: potential pathways of release to the environment (ground water movement and contamination, surface water contamination, other pathway of Release) Factors effecting the environmental behavior of chemicals (Physical and chemical factor, Degradation of Chemical)

Unit- III : Management of hazardous Wastes :-Introduction; the concept of cradle to grave management ; the legal aspects of Hazardous waste generation; storage and transport; selecting sampling procedures; planning for sampling; standard procedures for sample collection (solid/semi-solid/sludge /oil)

Unit-IV :- Treatment Technologies for hazardous wastes :-Introduction; physical treatment technologies; chemical treatment technologies; biological treatment technologies (Bioremediation); composting of Hazardous Wastes; factors affecting hazardous wastes; Thermal destruction (Incineration) technologies; Nuclear Hazards –Introduction; Exposure to radiation; Radiation Hazardous form working nuclear reactions; Sources of radiation; sources of radioactive contamination; hazardous from radioactive wastes .

Unit – V:- Safe disposal techniques of hazardous wastes :- 3 R` golden rule of hazardous waste ; International legislation guidelines; treaties and conventions on hazardous wastes and chemical; land filling; leachate management; land faming ; bioremediation; import and export of hazardous wastes.

Current developments in subject

ENV-545 : Practical paper-XIII [Core course with 02 credits]

- 1) Marginal information of toposheet and indexing of toposheet.
- 2) To study the conventional signs and symbols from toposheet and interpretation of toposheet.
- 3) To study of conventional signs and symbols from weather map and interpretation of weather map.
- 4) To study the principle and application of stereoscope and parelex bar and determine the closer and far floating objects by using stereoscope.
- 5) Identification of the objects from aerial photograph and scale determination of aerial photograph.
- 6) Cover study with the help of aerial photography and mapping of the land use patterns with the help of aerial photographs.
- 7) Ground truthing of the objects form aerial photograph/ Toposheet/ satellite image by using GPS.
- 8) Introduction to GIS SOFTWARE used for satellite image processing.
- 9) To study the landuse and land cover pattern with the help of satellite imageries.
- 10) To study the solid waste from house, hotel, garden, market and from industry.

ENV-546 : Practical paper-XIV [Core course with 02 credits]

- 1) To study the percentage composition of degradable and non-degradable material from solid waste.
- 2) Comparative study of physical parameters of solid waste i.e. pH, Moisture content and Ash content.
- 3) To study the percentage of potential recycling material from municipal solid waste.
- 4) Determination of total organic carbon present in compost prepared from solid waste.
- 5) Preparation of vermicompost from garden waste and municipal solid waste and to study its physical properties.
- 6) To study the calorific value of organic biomass from solid waste by titrometric method.
- 7) Geological investigations and identification of land fill sites for solid waste management.
- 8) To study the conventional signs and symbols used in the hazardous waste study.
- 9) To study the toxicity of hazardous waste collected from industry in common test specimen.
- 10) Preparation of EIA statement for development activities
- 11) Preparation of Environmental Audit Report of any one industry.

ENV- 547 : Practical paper-XV Project work [Core course with 04 credits]

Inplant Training and Project Work

The distribution of marks of this paper is as follow:

- i. Inplant training – 20 marks.(Internal assessment)
- ii. Project Work – 75 marks.(External assessment)
- iii. Tour report/Field visit report– 05 marks.(External assessment)

Note: i) The In plant training is to be given in summer vacation.
ii) The project work is to be allotted at the beginning of the IIIrd semester.

Project work on following areas will be preferably encouraged;

1. Non-conventional energy,
2. Energy issues,
3. Watershed Management,
4. Monitoring of Air, Water and Soil Pollution,
5. Pesticide Pollution,
6. Pollution control technologies,
7. Alternative technologies,
8. Pollution impact studies,
9. Health and sanitation studies,
10. Soil salinity and its reclamation,
11. Phytoremediation and bioremediation,
12. Recent advanced research areas in Environmental Science.

***Any other areas relevant to the subject**