

DEPARTMENT OF ENVIRONMENTAL SCIENCES

Faculty of Earth, Environment and Space Sciences



**M.Sc. ENVIRONMENTAL SCIENCES
SCHEME AND SYLLABUS
(Choice Based Credit System-CBCS)**

2019-2021

**INDIRA GANDHI UNIVERSITY
MEERPUR, REWARI**

M.Sc. Environmental Sciences, 2019-20 onwards
SCHEME OF EXAMINATION AND COURSE STRUCTURE
Based on Choice Based Credit System (CBCS)

M.Sc. Environmental Sciences shall be of two years duration Programme spread over four semesters.

1st Semesters shall consist of four Core courses of 3 credits each and 2 Discipline Centric Elective Course. The 2nd semester shall consist of 4 core papers and 1 **Discipline Centric Elective Courses (DCEC) of 4 credits each.** **The Discipline Centric Elective Courses/papers shall be provided by the department according to its administrative and academic convenience.** Foundation Course(s)(FC), as decided by the university, shall be offered to all students of the Department in 2nd semester and shall be of **2 credits**. The 3rd semester shall consist of 4 core courses, one Discipline Centric Elective Course of 4 credits each. 1 Open Elective Course is added in the 3rd semester of 3 credits. And the 4th semester consists of 4 core courses and 1 Discipline Centric Elective Course.

As decided by each Department of the university for the students of other Departments and the students of each Department have to opt one course out of a pool of OECs as decided by the University and each course shall be of 3 credits.

The medium of instructions shall be English.

The duration of examination for theory and practical courses/papers shall be of four hours. Practical examination shall be conducted by Board of Examiners consisting of either both the external examiners or the internal and external examiners, as the case may be. The Chairperson, Department of Environmental Science shall appoint the internal examiner from amongst the teachers of Department, preferably the teacher(s) who are engaged in the teaching of Practical Course/Paper and the external examiner out of the panel of examiners recommended by the P.G. Board of Studies and Research in Education.

Each course will be of 100 marks and foundation course will be of 50 marks. The marks of each course shall be in the ratio of 80:20, i.e. 80 marks for Theory Paper and 20 marks for Internal Assessment irrespective of the credits assigned to it and 40 marks for theory and 10 marks for internal assessment for Foundation Course. The Internal Assessment in each course/paper shall be based on one assignment of 05 marks each, 5 marks of attendance, 10 marks for the internal assessment tests of 5 marks each.

However, the distribution of the weightage of marks in the internal assessment and the minimum percentage of marks to pass the 'end semester examination' in each semester shall be as per the laid down norms/relevant ordinance of the University adopted from time to time.

INDIRA GANDHI UNIVERSITY, Meerpur, Rewari

Scheme of Examination for M.Sc. Environmental Sciences (Session 2019-2020)

Semester-I

Credits = 32

Marks = 650

Paper code	Subject	Type	Contact hours per week			Credits			Examination Schedule			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Int Assess	Practical	
EVS101	Technology, Environment and Society	CC	04		04	04		04	80	20		100
EVS102	Environmental Pollution	CC	04		04	04		04	80	20		100
EVS103	Biostatistics	CC	04		04	04		04	80	20		100
DISCIPLINE CENTRIC ELECTIVE COURSE (DCEC) (any two)												
EVS104	Tools & Techniques	DCEC	04		04	04		04	80	20		100
EVS105	Environmental Toxicology	DCEC	04		04	04		04	80	20		100
EVS106	Population explosion & sustainable development	DCEC	04		04	04		04	80	20		100
EVS107	Lab work I	CC		4X3	12		2X3	06			50	50
EVS108	Lab work II	CC		4X2	08		2X2	04			50	50
EVS109	Seminar/Journal club	CC						01				25
EVS110	Self study paper	CC						01				25
TOTAL			20	20	40	20	10	32	400	100	100	650

CC – Core Course DCEC – Discipline Centric Elective Course

INDIRA GANDHI UNIVERSITY, Meerpur, Rewari

Scheme of Examination for M.Sc. Environmental Sciences (Session 2019-2020)

Semester-II

Credits = 34

Marks = 700

Paper code	Subject	Type	Contact hours per week			Credits			Examination Schedule			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Int Assessment	Practical	
EVS201	Natural Resources	CC	04		04	04		04	80	20		100
EVS202	Biodiversity and Conservation	CC	04		04	04		04	80	20		100
EVS203	Environmental Impact Assessment	CC	04		04	04		04	80	20		100
EVS204	Environmental Chemistry	CC	04		04	04		04	80	20		100
DISCIPLINE CENTRIC ELECTIVE COURSE (any one)												
EVS205	Bioinformatics	DCEC	04		04	04		04	80	20		100
EVS206	Environmental management and planning	DCEC	04		04	04		04	80	20		100
FOUNDATION ELECTIVE COURSE												
EVS207	Communication skill and Personality Development	FEC	02		02	02		02	40	10		50
EVS208	Lab work I	CC		4X3	12		2X3	06			50	50
EVS209	Lab work II	CC		4X2	08		2X2	04			50	50
EVS210	Seminar/Journal club	CC						01				25
EVS211	Self study paper	CC						01				25
TOTAL			22	20	40	20	10	34	440	110	100	700

CC – Core Course
Course

FEC – Foundation elective course

DCEC – Discipline Centric Elective

INDIRA GANDHI UNIVERSITY, Meerpur, Rewari

Scheme of Examination for M.Sc. Environmental Sciences (Session 2019-2020)

Semester-III

Credits = 35

Marks = 750

Paper code	Subject	Type	Contact hours per week			Credits			Examination Schedule			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Int Assessment	Practical	
EVS301	Environmental Hazards & Disasters Management	CC	04		04	04		04	80	20		100
EVS302	Environmental Physics	CC	04		04	04		04	80	20		100
EVS303	Remote Sensing and Geographic Information System	CC	04		04	04		04	80	20		100
EVS304	Atmosphere and Global Climate Change	CC	04		04	04		04	80	20		100
DISCIPLINE CENTRIC ELECTIVE COURSE (any one)												
EVS305	Environmental Geology	DCEC	04		04	04		04	80	20		100
EVS306	Environmental Ethics and Philosophy	DCEC	04		04	04		04	80	20		100
EVS308	Lab work I	CC		4X3	12		2X2	06			50	50
EVS309	Lab work II	CC		4X2	08		3X1	04			50	50
EVS310	Seminar/Journal club	CC						01				25
EVS311	Self study paper	CC						01				25
OPEN ELECTIVE COURSE/MOOCs/SWAYAM												
EVS307	Hydrology and water resources	OEC	03		03	03		03	80	20		100
TOTAL			20	20	40	20	10	35	400	100	100	750

CC – Core Course OEC = Open Elective course DCEC – Discipline Centric Elective Course

INDIRA GANDHI UNIVERSITY, Meerpur, Rewari**Scheme of Examination for M.Sc. Environmental Sciences (Session 2019-2020)****Semester-IV****Credits = 32****Marks = 650**

Paper code	Subject	Type	Contact hours per week			Credits			Examination Schedule			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Int Assessment	Practical	
EVS401	Environmental Policies and Laws	CC	04		04	04		04	80	20		100
EVS402	Solid and Hazardous Waste Management	CC	04		04	04		04	80	20		100
EVS403	Environmental Management for Sustainable Development	CC	04		04	04		04	80	20		100
EVS404	Environmental Biotechnology	CC	04		04	04		04	80	20		100
DISCIPLINE CENTRIC ELECTIVE COURSE (Any One)												
EVS405	Environmental Issues In India	DCEC	04		04	04		04	80	20		100
EVS406	Environmental and Resource Economics	DCEC	04		04	04		04	80	20		100
EVS407	Lab Course I	CC		4X3	12			06				100
EVS408	Lab Course II	CC		4X2	08			04				100
EVS409	Seminar/Journal club	CC						01				25
EVS410	Self study paper	CC						01				25
TOTAL			20	20	32	20	10	32	400	100	100	650

CC – Core Course**DCEC - Discipline Centric Elective Course**

GrandTotal Credits: 32+34+35+32=133

Grand Total Marks: 2750

DEFINITIONS OF COURSES

1. CORE COURSE (CC)

Core Course (CC)

2. Subject related elective courses

DISCIPLINE CENTRIC ELECTIVE COURSES (DCEC)

3. Optional Courses within the Department.

OPEN ELECTIVE COURSES (OEC)

4. Foundation Course (FC):

Optional Courses which are to be opted out of a pool of courses from all departments as decided by the University.

Chairperson

Department of Environmental Science

Indira Gandhi University

Meerpur, Rewari

SEMESTER-I

M.Sc. Environmental Sciences: Semester-I
TECHNOLOGY, ENVIRONMENT AND SOCIETY
Course Code-EVS101CC
Exam Course Code-101

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

TECHNOLOGY, ENVIRONMENT AND SOCIETY

Preamble: A study of the relationship between technology and environment with the aim to understand the role and contribution of different types of economic and social mechanisms that the contemporary societies have been able to evolve to shape the technological changes in the direction of sustainable development and to achieve ecological and social justice.

UNIT I

Understanding the relationship of technology with environment through the analysis of shifts in the perceptions of societies in the countries of technologically advanced and developing world. Study of “technological innovation as a solution/ remedy for environmental problems”, “technological impacts / innovation and technology adoption effects of environmental policies”;

UNIT II

Environmental policy assessment for the evaluation of impact on environmental costs, assessment of the effectiveness of alternate policy instruments in containing environmental damage, the encouragement to technology transitions and environmental technology innovations for the achievement of ecological and social justice.

UNIT III

Assessments of the developments within the relevant fields of science and technology for the achievement of sustainable development in the world in general and in India in particular; the management of transition to environmentally and socially just futures for energy, transportation, climate change, handling of toxics, agriculture, water, forests, etc.

UNIT IV

Impacts of social movements for the achievement of ecological and social justice in India; corporate responsibility movement, appropriate technology movement, environmental groups and movements, citizen groups, etc.; developments within the field of integrated technology assessment, innovation policy tools, pathways creation for sustainable development, etc.

Suggested Readings:

Elliot David, 2003, Energy, Society and Environment, Technology for a Sustainable Future, Routledge

Jasanoff Sheila, 2002, New Modernities: Reimagining Science, Technology and Development, In Environmental values.

Jasanoff Sheila, 2003, Technologies of Humility: Citizen participation in governing science, In Minerva.

Juma. C, Konde. V, 2002, Technical change and sustainable development, Developing country perspectives, American association for the advancement of science (AAAS).

Makofske, W.J. and Karlin, E.F., 1995, Technology and Global Environmental issues, Addison Wesley Longman, Toronto.

Mawasley. E, 2004, India's middle classes and the environment development and change.

Vernon W. Ruttan, 2000, Technology, Growth, and Development: An Induced Innovation Perspective, Oxford University Press, New York.

Visvanathan Shiv, 2000, Environmental values, Policy and conflict in India, Carnegiecouncil.org

M.Sc. Environmental Sciences: Semester-I

ENVIRONMENTAL POLLUTION

Course Code-EVS102CC

Exam Course Code-102

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

ENVIRONMENTAL POLLUTION

Study related to air, water and soil pollution and pollutants: their sources and measures to quantify the effects of these pollutants. Noise Pollution and its ill-effects. The understanding of measures to curb the pollution.

UNIT – I

Air pollution- natural and anthropogenic sources of pollution, primary and secondary pollutants, transport and diffusion of pollutants, Meteorological aspects of air pollutant dispersion, Air pollution control equipments, cyclones, filters, scrubbers.

UNIT - II

Water pollution - types sources and consequences of water pollution Characteristics of domestic industrial and agricultural waste and their effects on water bodies, water quality parameters, standards, and criteria, sewage and wastewater treatment and recycling, water quality and standards.

UNIT - III

Soil pollution and its control, Harmful effects of soil pollutants, Chemical method of soil analysis- sample preparation and soil analysis. Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, Industrial effluent and surfactant.

UNIT - IV

Noise pollution - sources of noise pollution, measurement and indices, Noise control and abatement measures. Thermal pollution, sources of thermal pollution and its control, Effects of pollutants on human beings, plants, animals and climate.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Murlikrishan, K.V.S.G. (2016),*Air Pollution and Control*, First Edition, Laxmi Publications Private Limited.
2. Bell&Bell,(1993),*Industrial Noise Control*, Second Edition,CRC Press
3. Peavy, H.S.(2017),*Environmental Engineering*, First Edition, McGraw Hill Education.
4. Warren, C.E. (1971),*Biology and Water Pollution Control*, Saunders (W.B.) Co Ltd
5. Kanan, K.(1999),*Fundamental of Environmental Pollution*, 2nd edition ,S.Chand (G/L) & Company Ltd
6. Trivedi &kudesia, (1992),*Environmental Air Analysis*, Akashdeep pub.
7. Pandey,V,(1995), *Noise Pollution*, Meerut publishers
8. Rao, C.S., (2006),*Environmental Pollution ControlEngineering*, Second editionNew Age International Publishers
9. Rao, M.(1993),*Air Pollution*, McGraw Hill Education
10. Noel de nevers, (1993),*Air pollution control and engineering*, McGraw hills,
11. Samuel, j.w.(1971),*Fundamental of air pollution*, Addison Wesley publishing

Exam Course Code-103

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Biostatistics: The aim of the paper is to impart the basic knowledge about the statistics techniques such as, handling data, calculating central tendencies and performing simple statistical tests like correlation, ANNOVA, regression etc.

Unit-I

Permutation and combination, functions, limits and continuity, exponential and logarithmic functions, differential calculus: Rules of differentiation, higher derivatives, Maxima and minima, integration, integration by parts, definite integrals, properties of definite integrals, elementary ideas of differential equations

Unit-II

Types of data, collection and graphical representation of data, Measures of central tendency: Mean, Mode, Median, Quartile, Percentile, measures of dispersion: Range, variance, Standard deviation, Coefficient of variation, correlation and regression.

Unit-III

Probability and its application: Laws of addition and multiplication, compound probability, Bayes theorem, Probability distribution: Binomial, poisson and Normal distribution and their application. Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error, Null Hypothesis and Alternative hypothesis, Simple and composite hypothesis, Two types of errors, level of significance and power of the test, one tailed and two tailed test

Unit-IV

Tests of significance, tests for proportion, t and F tests for mean and proportion for one and two samples, 2 (Chi square) tests of goodness of fit and independence. F test, analysis of variance for one way and two way classification, Elementary ideas of design of experiment

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Suggested Readings:

1. Biostatistics By PN Arora and PK Malhan, Himalaya Publishing House.
2. Experimental Design and Data Analysis for Biologists By Gerry P. Quinn and Michael J. Keough. Publisher: Cambridge University Press.
3. Principles of Biostatistics (with CD-ROM) (Hardcover) By Marcello Pagano and Kimberlee Gauvreau. Publishers: Duxbury Press
4. Biostatistics: Experimental Design and Statistical Inference (Hardcover) By James F.Zolman. Oxford University Press.
5. Intuitive Biostatistics By Harvey Motulsky. Publisher: Oxford University Press.
6. Introduction to Biostatistics by Robert R. Sakal and F. James Rohlf: Dover Publications, Inc. Mineola, New York.
7. Introductory Biostatistics by Chap T. Le: A John Wiley & Sons Publication

M.Sc. Environmental Sciences: Semester-I
TOOLS AND TECHNIQUES
Course Code-EVS104DCEC
Exam Course Code-104

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Tools and Techniques: The paper aims at conveying the various techniques used in environmental sciences studies and various tools used. Theoretical knowledge about chromatography, inflorescence, spectrophotometry, polymerase chain reaction is essential.

Unit – I

Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Titrimetry, Gravimetry, Colorimetry, Microscopy-phase, light and fluorescence microscopes, Scanning and Transmission electron microscopes.

Unit - II

Chromatographic techniques (Paper chromatography, thin layer chromatography, Ion exchange chromatography, Column chromatography), Atomic absorption spectrophotometry, Principles and techniques of nucleic acid hybridization and Cot curves.

Unit - III

Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry, Gas-liquid chromatography, High pressure liquid chromatography – autoradiography, Ultracentrifugation.

Unit- IV

Methods for measuring nucleic acid and protein interactions, DNA finger printing Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, PCR polymerase chain reaction.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Uppadahay -Uppadahay and Nath(2016),*Principles of Biophysical chemistry*. 4th edition Himalaya Publishing House.

2. Sharma B. K., *Instrumental Methods of Analysis*, Goel Publishing house.
3. Sharma Y.R. (2008), *Elementary Organic Spectroscopy*, S.Chand & company Ltd. New Delhi
4. Allen J. Bard and Larry R. Faulkner, (2001), *Electrochemical Methods*, 2nd Ed., John Wiley & Sons
5. APHA. (2012). *Standard Method for the Examination of Water and Waste water*, Washington, D.C.
6. Christian G.D. (2000), *Analytical Chemistry*, 6th ed, John Wiley & Sons
7. De. A.K. (1994). *Environmental Chemistry*. New Age International Ltd. New Delhi
8. Ewing G.W. (1985). *Instrumental Methods of Chemical Analysis*, 5th Ed., Mc-Graw Hill Book Company.
9. Radojecic M. and Bashkin V.N. (2007), *Practical Environmental Analysis*. RSC Publishing, Cambridge.
10. Skoog D.A., F.J. Holler and Nieman, (2003). *Principles of Instrumental Methods*, 5th Ed., Thomson Asia Pvt. Ltd., Singapore.
11. Vogel A.I. (1999). *Textbook of Quantitative Chemical Analysis*, 5th Ed., Addison Wesley Longman Singapore Ltd.
12. Willard, Merritt, Dean, and Settle, (1986). *Instrumental Methods of Analysis*, 7th Ed., C B S Publishers & Distributors.

M.Sc. Environmental Sciences: Semester-I
ENVIRONMENTAL TOXICOLOGY
Course Code-EVS105DCEC
Exam Course Code-105

End Semester Exam: 80 marks
Internal Assessment: 20 marks
Total: 100 marks

Time: 3 hrs.

Environmental Toxicology: The paper introduces to the students about the toxic substances present in the environment and their ill-effects on life. The paper will introduce the role of toxic substances, epidemiological issues related to toxicity and the methods to protect life and biodiversity.

Unit – I

Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemical aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticides.

Unit - II

Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

Unit - III

Insecticides, MIC effects, Concept of major, trace and Rare Earth Element (REE)-possible effects of imbalance of trace elements

Unit- IV

Biogeochemical factors in environmental health, Epidemiological issues goitre, fluorosis, arsenic poisoning.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Calow.P. (1994). *Handbook of Ecotoxicology*. Blackwell Scientific Publications, London
2. Chatterji,M., MunasingheM. and GangulyR.. (1998). *Environment and Health in Developing Countries*. A.P.H.Publishing House, New Delhi.
3. Forbes,V.E. and T.L.Forbes. (1994). *Ecotoxicology in Theory and Practice*. Chapman & Hall, London.
4. Hayes, W.A.(2001). *Principles and Methods of Toxicology*, CRC, USA.
5. Jacobson-Kram,D. (2006). *Toxicological testing handbook: Principles, Applications and Data Interpretation*, Taylor and Francis, New York.
6. Klaassen,C.D. and Watkins,J.B. (2003). *Essentials of Toxicology*, McGrawHill Professional, New Delhi.

7. Levin,S.A. and.HarwellM.A, KelleyJ.R.and.KemballK.D. (1989). *Ecotoxicology: Problems and Approaches*. Springer-Verlag, New York.
8. Manahan,S.E. (2000). *Environmental Chemistry*, Lewis Publishers, New York.
9. Pery,G.(1980). *Introduction to Environmental Toxicology*, Elsevier, Amsterdam.
10. Walker,C.H., R.M.Sibly, S.P.Hopkin and D.B.Peakall. (2012). *Principles of Ecotoxicology*, CRC Press, New York.
11. Wright,D.A. and Welbourn,P. 2002. *Environmental Toxicology*, Cambridge University Press, London.

M.Sc. Environmental Sciences: Semester - 1
POPULATION EXPLOSION & SUSTAINABLE DEVELOPMENT
Course Code = EVS106DCEC
Exam Course Code = EVS106

End Semester Exam: 80 marks
Internal Assessment: 20 marks
Total: 100 marks

Time: 3 hrs.

UNIT - I

Growth and distribution of population in the world and India; concepts of over population, under population and optimum population.

Migration; Causes and consequences of migration; Demographic attributes: sex-ratio, age structure, literacy rate, work-force, dependency ratio, longevity.

UNIT - II

Environmental issues and crisis: Environmental hazards, Environmental pollution; Environmental degradation; Deforestation, desertification and soil erosion; Energy crisis; Resource degradation.

UNIT – III

Sustainable Development: concept of Sustainable Development; Global and regional dimensions of Sustainable Development. Concept of sustainable urban development; Sustainable Cities; urban sprawl.

UNIT – IV

Governments and International Agreements for Sustainable Development, Commission on Sustainable Development (1992), United Nations Conference on the Human Environment (1972) Brundtland Commission (1983) The Rio Declaration on Environment and Development (1992).

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks

Recommended Readings:

1. Barrow, C., (2006), *Environmental Management and Development*, 2nd edition
2. Elliott, J. A. (2006), *An Introduction to Sustainable Development*, 3rd edition
3. Oberai, A.S. (1987), *Migration, Urbanization and Development*, International Labour Office, Geneva
4. United Nations, (1983), *Determinants and Consequences of Population Trends*, Vol 1, UN, New York, Chapter-VI.
5. Bhende, A., (1996), *Principles of Population Studies*, Seventh Edition, Himalaya Publishing House, Bombay.
6. Botkin, D. B. and Keller, E. A., (2007). *Environmental Science: Earth as a Living Planet*, 6th ed. John Wiley & Sons, USA.
7. Cunningham, W. P. and Cunningham, M. A (2004), *Principles of Environment Science. Enquiry and Applications*, 2nd ed. Tata McGraw Hill, New Delhi.
8. Rajagopalan, R., (2008) *Environmental Studies: From crisis to cure*, Oxford University Press, New Delhi.
9. Richards, I. S. (2008), *Principles and Practice of Toxicology in Public Health*, Jones and Bartlett Publishers, London.
10. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology (2006), *Environment and Resource Conservation*, Anamaya Publishers, New Delhi, India.
11. World Commission on Environment and Development (WCED): *Our Common Future*, (1987), Oxford University Press, London..
12. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
13. Tiwari, R. K., (2007), *Global Environmental Policies*, A B D Publisher.
14. Singh T. (2006), *Disaster management Approaches and Strategies*, Akansha Publishing House, New Delhi.
15. Harris, F. (2004), *Global Environmental Issues*, Wiley & Sons, Inc., USA.

M.Sc. Environmental Sciences: Semester-1
PRACTICALS –LAB COURSE-I
Course Code-EVS107
Exam Course Code-107

Max. Marks:50

Time: 4 Hours

Distribution of Marks:

Lab work test:30

Record on lab work:10

Viva Voce:10

COURSE OBJECTIVES:The objective of the course is to develop the analytical skills of the students for water quality testing of drinking water

List of Experiments

1. To measure the temperature of given water sample.
2. To determine pH of given water sample.
3. To determine conductivity of given water sample.
4. To determine total solids, suspended solids, volatile solids, in given water sample.
5. To determine total hardness of given water sample.
6. To determine dissolved oxygen by Winkler's method.
7. To determine Biological Oxygen Demand (BOD)of waste water sample.
8. To determine chemical oxygen demand (COD) of waste water sample.
9. Nitrates determination
10. Sulphates determination
11. Diatoms determination

Recommended Readings

1. APHA. 2012. Standard Method for the Examination of Water and Waste water, Washington, D.C.
2. Waste water engineering, Met Calf &Eddy;INC, Tata mc Graw Hill.
3. Indian standard for drinking water, BSI, New Delhi.
4. Water supply & sanitary engineering, Birdie G. S., Dhanpat Rai & Sons, New Delhi.

M.Sc. Environmental Sciences: Semester-1
PRACTICALS –LAB COURSE-II
Course Code-EVS108
Exam Course Code-108

Max. Marks: 50

Time: 4 Hours

Distribution of Marks:

Lab work test: 30

Record on lab work: 10

Viva Voce: 10

COURSE OBJECTIVES:The objective of the course is to develop the analytical skills of the students for water quality testing of drinking water

List of Experiments

Spectrophotometry: Use of Spectrophotometer, Phosphate, Nitrate and Sulphate analysis

Chromatography: Paper, Thin Layer Chromatography

Air Sample: Particulate matter 10 and 2.5, NO

Noise: Sand level, SO

Electrophoresis

Practicals:

Descriptive statistics: Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculators). 2. Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting). 3. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages). 4. Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data 5. Testing of hypotheses: Tests of significance (mean, standard deviation, correlation coefficient), chi-squared test for goodness of fit, test for independence of attributes, nonparametric tests (run test) using calculators and printed tables and using minitab sampling (drawing random samples using random numbers, tables, chits, computer programmes for random number generation), design of experiments, ANOVA (oneway and two-way)

SEMESTER –II
M.Sc. Environmental Sciences: Semester-2
NATURAL RESOURCES
Course Code-EVS201CC
Exam Course Code-201

End Semester Exam : 80 marks
Internal Assessment : 20 marks
Total : 100 marks

Time : 3 hrs.

Natural Resources:

This paper takes an objective view of the nature of Earth's resources, particularly the nonrenewable resources, how and where they are generated, how they are extracted and used, and how these activities impact Earth's environment. It also addresses sustainability by looking into different ways of conservation of the natural resources and their management.

UNIT – I

Energy: Past, Today, and Future, Energy consumption measure of prosperity, Needs of renewable energy, advantages and limitations of Renewable Energy, present energy scenario of conventional and non-conventional energy sources. Fossil fuels classification, composition, physico-chemical characteristics and energy content of coal, petroleum and Natural gas. Fossil fuels and their global distribution. Nuclear energy- fission and fusion, Hydrogen as a source of energy.

UNIT - II

Sun as a source of energy, solar radiations and its spectral characteristics, solar collectors, photovoltaic, solar ponds, Principles of generation of hydroelectric power, tidal power, ocean thermal energy conversion, wind, geothermal energy, Bio energy -energy from biomass and biogas, anaerobic digestion, energy use patterns in different parts of the world. Impacts of large scale exploitation of solar, wind, hydro and ocean energy.

UNIT - III

Mineral resources and reserves, ocean ore and recycling of resources, Environmental impact of exploitation, processing and smelting of Mineral, oceans as need areas for exploitation of Mineral resources.

UNIT IV

Forest and Wildlife resources: Types of forests, distribution, uses. Wildlife, conservation, national parks, reserves, etc.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Recommended Readings:

1. Miller T.J. (2014), *Living in the environmental*, 18th edition, Brooks Cole.
2. Owen & Chiras (2009), *Natural resource conservation*, 10th edition, Pearson
3. Encyclopedia Energy - I & II.
4. Tiwari G.N. Ghoshal M.K., Narosa, (2007), *Fundamental of Renewable Energy Sources*.
5. Donahue R.L. and Miller R.W. (1997), *Soils In Our Environment*, Prentice Hall of India Pvt. Ltd., New Delhi.
6. Morgen, M.D. Morgen J.M. and Wiersima J.H. (1993), *Environmental Science : Managing Physical and Biological Resources* Wm C Brown Publishers London.
7. Tyler Miller Jr. G. (2005). *Living in the Environment*. Wadsworth Publishing Company, Belmont California.
8. Botkin, D.B and Keller E.A., (2000), *Environmental Studies : The earth as a living plant*. Charles E. Merrill, Publishing Co. London.
9. Shastri M.N. (1995), *Energy Options* : Himalaya Publishing House, New Delhi.
10. Dhaliwal G.S., Sangha G.S. and Ralhan P.K. (2000), *Fundamentals of Environmental Science*, Kalyani Publishers, New Delhi.
11. Singh J.S., Singh S.P. and Gupta S.R., (2006), *Ecology Environment and Resource Conservation*, Anamaya Publishers, New Delhi.

M.Sc. Environmental Sciences: Semester-2

BIODIVERSITY & CONSERVATION

Course Code-EVS202CC

Exam Course Code-202

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Biodiversity and Conservation:

This course entails the study of diversity existing at different levels of Biological organization and understanding the essential ecological and biological processes which ensures long terms stability of ecosystems. The course highlights the values of biodiversity and scientific approaches to conservation which only can lead to sustainable development and safeguard the interests of future generations.

Unit - I

Biodiversity –definition, Composition and Scales of Biodiversity: Genetic Diversity, SpeciesDiversity, Ecological/Ecosystem Diversity, Aquatic common flora and fauna in India - phytoplankton, zooplankton and macrophytes, terrestrial common flora and fauna in India - forests,

Unit - II

Hotspots of Biodiversity, Endangered and threatened species, threats to Biodiversity- Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems.

Unit - III

Strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool, cryopreservation, gene banks, tissue culture and artificial seed technology, new seed development policy 1988, conservation of medicinal plants.

Unit- IV

International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind, Values of Biodiversity -Instrumental/Utilitarian value and their categories, Direct use value; Indirect/ Non-consumptive use value, Intrinsic Value; Ethical and aesthetic values.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Ramade, F.(1984),*Ecology of natural resource*, John Wiley & Sons Ltd
2. P.D. Sharma-Ecology
3. Krishnamurthy, K. V. (2003). *Textbook of Biodiversity*. Science Publication.
4. Van Dyke, F.(2008).*Conservation Biology Foundations, Concepts, Applications*

2nd Edition, Springer.

5. Chandel, K.P.S., Shukla, G. And Sharma, N. (1996). *Biodiversity in Medicinal and Aromatic Plants in India Conservation and Utilization*, National Bureau of Plant Genetic Resources, New Delhi.
6. Council of Scientific and Industrial Research (1986). *The Useful Plants of India* Publication and Information Directorate, CSIR, New Delhi.
7. Nair, M.N.B. (1998). *Sustainable Management of Non-wood Forest Products*. Faculty of Forestry, University Putra. Malaysia. 434 004 PM Serdang, Selangor, Malaysia.
8. Soule, M.E. (1986). *Conservation Biology. The Science of Scarcity and Diversity*. Sinaur Associates, Inc., Sunderland, Massachusetts.
9. Singh, J.S., Singh, S.P. and Gupta, S.R.(2006). *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi.
10. Botkin, Daniel B. and Keller, Edward A(2007).*Environmental Science: Earth as a Living Planet*. 6th ed. John Wiley & Sons, USA.
11. Enger, E.D. and Smith, B. F.(2006)*Environmental Science: A Study of Interrelationships*. 11th ed. McGraw Hill Inc., USA.
12. Frankel, O.H., Brown A.H.D. and Burdon, J.J.(1995)*Conservation of Plant Biodiversity*. Cambridge University Press, UK.
13. Gadgil, Madhav and Rao, P.R.S. (1999),*Nurturing Biodiversity: An Indian Agenda*. Centre for Environment Education, Ahmadabad, India..
14. Heywood, V.H. and Watson, R. T. (1995),*Global biodiversity Assessment*. UNEP-Cambridge,.
15. Hunter, Malcolm L., Jr., and Gibbs, James P. (2006),*Fundamentals of Conservation Biology*. 3rd ed. Wiley-Blackwell.
16. Jeffries, M.(1997),*Biodiversity and Conservation*. 2nd ed. Routledge, UK..
17. Reports And Statistics on Dynamic Ground Water Resources of India, Govt. Of India, Ministry of Water Resources.

M.Sc. Environmental Sciences: Semester-2
ENVIRONMENTAL IMPACT ASSESSMENT

Course Code-EVS203CC

Exam Course Code-203

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Environmental Impact Assessment:

This paper is an introduction to EIA, a systematic process that examines the environmental consequences of development actions, in advance. This process is firmly on the agenda of all environmental agencies as a result of introduction of legislations in various countries.

Unit - I

Introduction to environment impact analysis, Objectives and development of EIA. Benefits of EIA, Indian directions of EIA. Rapid and comprehensive EIA perspectives. EIA guidelines 1994, Notification of Govt. of India. EIA guidelines 2006 and amendments

Unit –II

EIA Methodology: Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Baseline studies; checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS]; Public hearing as part of EIA; EIA report.

Unit –III

Environmental Management and ISO Certification: Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System-Objectives, Policies, Implementation and Review. Life Cycle Analysis –LCA. Waste minimization and product augmentation.

Unit- IV

Public Participation: Social impact assessment (SIA), Strategic Environmental Assessment (SEA), Mitigation criteria, Project modification, Post project analysis. Risk analysis - definition of risk, Environmental risk analysis- hazard identification, dose- response assessment, exposure assessment, Risk characterization.

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Glasson, J. (2011), *Introduction to Environmental Impact Assessment*, 4 edition
Routledge
2. Aggarwal S.K (1996), *Industrial Environment - Assessment and strategy* APH Pub. Corp.
3. Anjaneyulu, Y. and Manickam, V. (2002), *Environmental Impact Assessment Methodologies*. B.S. Publications.
4. Boland, R.G.A. (1993), *Environmental Management Training*. Sterling Publishers Pvt. Ltd. New Delhi,
5. Canter, L. (1996), *Environmental Impact Assessment*. 2nd Edition. McGraw-hill Book Company, New York.
6. Cutter, S.L.(1999), *Environmental Risks and Hazards*, Prentice Hall of India, New Delhi.
7. Kulkarni, V. and Ramachandra, T.V.(2006), *Environmental Management*, Capitol Pub. Co., New Delhi.
8. Morris, P. and Therivel R. (2001), *Methods of Environmental Impact Assessment*, 2nd Edition, Spon Press London.
9. Paliwal, U.L(2002), *Environment Audit*. Indus Valley Publications. Jaipur.
10. Petts, J., *Handbook of Environmental Impact Assessment- Volume 1 and 2*. Blackwell

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

ENVIRONMENTAL CHEMISTRY

The course introduces the students to some basic chemistry relevant to the course, and to the general chemistry of the lithosphere, hydrosphere and atmosphere. Emphasis is also placed on understanding the chemistry of various anthropogenic pollutants and basic analytical techniques.

UNIT I

Basic Chemistry: Structure of atoms, their properties, their nuclear stabilities and their arrangement in the Periodic Table; fundamentals of chemical thermodynamics and solution formation; basic organic chemistry and biochemistry. Geochemistry: Structure and chemistry of silicate and ore minerals; bulk composition of the earth, crust, & oceans; rock weathering, clay minerals and soil formation; cycling of chemical elements in the earth system.

UNIT II

Chemistry of waters: properties of water; sources of water and their linkages – hydrologic cycle; concepts of pH, Eh and their variations in waters; metal solubility, complexation and chelation; aquatic life and water chemistry; organic and inorganic including radioactive water pollutants and their removal methods.

UNIT III

Atmospheric Chemistry: Physical and chemical properties of atmospheric air and their variation with latitude and altitude; chemical reactions in air and the residence time of CO and the greenhouse gases aerosols, their chemistry, sources and transport; organic compounds in air and their sources; physical and health effects of air chemistry changes, global warming and acid rain.

UNIT IV

Chemistry of waste substances: Nature and types of various wastes such as mining, industrial, agricultural, municipal, medical and nuclear; chemical and biological treatment of wastes before disposal; chemistry of toxic inorganic and organic compounds in the environment and their interactions with living system.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Suggested Readings:

Manahan. Stanley E, 2000, 7thEdn., Environmental Chemistry, Lewis Publishers.

Stumm, W.; Morgan, J. J., 1996, Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters; Wiley Interscience: New York,.

Wayne, R. P., 2000, Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Oxford University Press,

Williams Ian, 2001, Environmental Chemistry –a modular approach, Wiley John & Sons

Williams. R.J.P and Frausto da. J.J.R, 1996, The Natural Selection of the Chemical Elements, Oxford University Press, Oxford, UK /New York, NY

Willard & Others, 1988, Instrumental Methods of Analysis, Wadsworth.

M.Sc. Environmental Sciences: Semester-2

BIO-INFORMATICS

Course Code-EVS205DCEC

Exam Course Code-205

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Computers: An overview of computers, microcomputers, VDUs and printer; What is programming? Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to SQL (structured query language) Handling arrays, procedures. Colour, sound and graphics; Use of standard packages.

Unit-II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Pattern modifiers. **Applications of PERL in Bioinformatics:** Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA

Unit-III

Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Preliminary ideas of query and analysis of sequence information.

Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch&SmithWaterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method.Theory of scoring matrices and their use for sequence comparison.

Unit-IV

Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Pattern Recognition

Methods in Sequence Analysis: Concept of a sequence pattern, regular expression based patterns. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAST. Markov chains and Markov models and their use in gene finding. Concept of HMMs, the Forward backward and the Viterbi algorithm. The Baum Welch algorithm for training a HMM. Use of profile HMM for protein family classification.

Suggested Laboratory Exercises:

1. Retrieve Nucleotide sequences from NCBI serve.
2. Retrieve Protein sequences from PDB.
3. Analysis of sequences Similarity using BLAST/pBLAST/nrBLAST
4. To predict protein secondary structures by using iPred.
5. Perform phylogenetic analysis using PHYLIP.
6. Perform multiple sequence alignment by using ClustalW.
7. Primer design
8. Computational modeling of genomic, transcriptomic and proteomic

Suggested readings:

1. JinXiong. 2006. Essential Bioinformatics. Cambridge publisher
2. Zhumur Ghosh and Bibekanand Mallick. 2008. Bioinformatics: Principles and Applications. Oxford University Press publisher
3. Orpita Bosu and Simminder Kaur Thukral. 2007. Bioinformatics. Oxford University Press publisher
4. M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press publisher
5. Dan E. Krane, Michael L. Raymer, Michael L. Raymer, Elaine Nicpon Marieb. 2002. Fundamental Concepts of Bioinformatics Benjamin/Cummings
6. P. Rastogi and N. Mendiritta. 2013. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd; 4th Revised edition.
7. Mount and David W. 2004. Bioinformatics: sequence and genome analysis. Cshl Press, 2nd edition
8. Harisha S. 2007. Fundamentals of Bioinformatics. I K International Publishing House Pvt. Ltd .
9. Dan E. Krane. 2003. Fundamentals concepts of bioinformatics. Dorling Kindersley (RS); First edition .
10. David Edwards and Jason Stajich. 2009. Bioinformatics: Tools and Applications. Published by Springer.

M.Sc. Environmental Science: Semester-2
ENVIRONMENTAL MANAGEMENT AND PLANNING
Course Code-EVS206DCEC
Exam Course Code-206

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Environmental Management and Planning:

UNIT - I

Role of NGO's in public participation in environmental movements, Concepts of Environmental education and awareness Internationals environmental initiatives - the club of Rome report, Stockholm Declaration, environmental ethics.

UNIT - II

Vehicular pollution and urban air quality, Fly ash utilization, Eutrophication and restoration of Indian lakes, Wet land conservation, Water crisis-conservation of water.Narmada dam, Tehri dam, Almetti dam.

UNIT - III

Basic concepts of environmental planning, Environmental priorities in India, Land use planning: The land use plan (India). Soil surveys in relation to land use planning. Methods of site selection and evaluation, soil erosion, Formation and reclamation of Usar, alkaline and saline soil, waste lands and their reclamation, Desertification and its control.

UNIT - IV

Urban planning and rural planning for India. Sustainable development- principles and practices in relation to economics and ecology. Cost-benefit analysis- its relevance.Ramsar convention on wetlands, Vienna convention and Montreal Protocol, Kyoto protocol, Earth Summit, Agenda-21.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Saxena.K.D. ,*Environmental Planning, Policies & Programmes in India*
2. Anderson, David A. (2013) *Environmental economics and natural resource management*, 4th Edition Taylor and Francis.
3. Singh G. (2007) *Land resource management*, Oxford publishers.
4. Kathy Wilson Peacock. (2010) *Natural resources and sustainable developments*. Viva books.
5. Lynch, Daniel R. (2009) *Sustainable natural resource management for scientists and engineers*, Cambridge University Press.
6. Jaidev, Somesh (2010) *Natural resources in 21st century*. Oxford Publishers.
7. Kudrow, N. J (Ed) (2009) *Conservation of natural resources*, Nora Science, New York.
8. Kumar, H.D. (2001) *Forest resources: Conservation and management*. Affiliated EastWest Press.
9. Grigg, N. S. (2009) *Water resources management: Principles, regulations, and cases*, McGraw Hill Professional.
10. Beckman, D. W. (2013) *Marine environmental biology and conservation*. Jones and Barlett learning.
11. Primak R.B (2014) *Essentials of Conservation biology*, 6th edition, Sinauer Publishers.

M.Sc. Environmental Sciences: Semester-2
COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT
Course Code-EVS207FC
Exam Course Code-207

End Semester Exam: 40 marks

Internal Assessment: 10 marks

Total: 50 marks

Time: 2 hrs.

Communication Skills: The paper aims at developing communication skills among students using verbal and non-verbal techniques. Training students to use of mass media, developing effective speaking and writing skills.

Unit-I

Human Communication (Theoretical perspective): Its uniqueness, its nature, models of communication. Types of Human communication, Language, non-verbal communication, logic and reasoning, lateral thinking. The concept of facilitating: factors, barriers and filters in communication; the seven C's of effective communication, Preparing for interviews, CV/Biodata.

Unit -II

Self-communication, interpersonal communication, dyadic communication, small group communication. Public communication. Mass Communication, Reliability of communication. Input and Evaluation Processes (Practice): Listening (process, comprehension, evaluation). Reading (process, comprehension, evaluation). Watching (process, comprehension, evaluation). Email Do's and Don'ts.

Unit -III

Output and Interaction Processes (Practice): Speech (conversation, interview, group discussion, public speech). Writing (spontaneous writing, guided writing, creative writing). Organizing ideas (noting, summary, flow charts, concept maps). Correspondence (personal, business).

Unit-IV

Science / Scientific Writing (Theory and practice): Goals and Objectives. Ethics in writing. Structure of documents. Language and grammar. Illustrations and aids. Writing proposals and instructions. Making presentations. Formatting documents. Drafts and revisions. Editing. Writing popular science / journal article. Session:

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Suggested Readings:

1. Communicating a social and career focus, K. M. Berko, Andrew D. Wolvyn and Darlyn R. Wolvyn, Houghton Mifflin Co., Boston (1977)
2. The Craft of Scientific Writing (3rd Edition), Michael Alley, Springer, New York (1996)
3. Science and Technical Writing – A Manual of Style (2nd Edition), Philip Reubens (General editor), Routledge, New York (2001)
4. Writing Remedies – Practical Exercises for Technical Writing Edmond H. Weiss, Universities Press (India) Ltd., Hyderabad (2000)
5. Effective Technical Communication, M. Ashraf Rizvi, Tata Mc Graw – Hill Publishing Co. Ltd., New Delhi (2005)

M.Sc. Environmental Sciences: Semester-2
PRACTICALS-LAB COURSE-I
Course Code-EVS208
Exam Course Code-208

Max. Marks : 50

Time : 4 Hours

Distribution of Marks :

Lab work test : 30

Record on labwork : 10

Viva Voce : 10

COURSE OBJECTIVES: The objective of the course is to develop the analytical skills of the students for water and wastewater so that they can apply these in wastewater and industrial treatment plants.

List of Experiments

1. Study of Physical characteristics of water: Colour, Odour, Turbidity, Temperature.
2. Potentiometric determination of pH of water/wastewater and soil samples.
3. Conductivity of water and wastewater samples using conductivity and TDS meter.
4. Working, standardization of flame photometer and plotting calibration curve for metal ions.
5. Determination of Total Organic Content.
6. Flocculation studies of wastewater samples.
7. Field visit to river/lake and water and wastewater treatment plants.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

Recommended Readings:

1. APHA. (2012). Standard Method for the Examination of Water and Waste water, Washington, D.C.
2. Waste water engineering, Met Calf &Eddy ;INC, Tata mc Graw Hill.
3. Indian standard for drinking water, BSI, New Delhi.
4. Birdie G. S., Dhanpat Rai &Sons.,Water supply & sanitary engineering, , New Delhi.
5. Manual on sewerage & sewage treatment, Ministry of works & housing, New Delhi.
6. Waste water treatment plant design(, 1977), A manual of practice, Water pollution control federation

M.Sc. Environmental Sciences: Semester-2
PRACTICALS-LAB COURSE-II
Course Code-EVS209
Exam Course Code-209

Max. Marks : 50

Time : 4 Hours

Distribution of Marks :

Lab work test : 30

Record on labwork : 10

Viva Voce : 10

COURSE OBJECTIVES: The objective of the course is to develop the analytical skills of the students for water and wastewater so that they can apply these in wastewater and industrial treatment plants.

List of Experiments

Practical:

Sample preparation methods: Types & calibration of standards for soil & water analysis.

Chemical analysis of water & waste water; Analyses of wastes & solids; Air & gas analysis;

Analysis of biological materials.

Familiarity with instrumental techniques for basic Chemical analysis: chromatography, spectrophotometer, fluorometry.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

SEMESTER-III

M.Sc. Environmental Sciences: Semester-3
ENVIRONMENTAL HAZARDS AND DISASTERS MANAGEMENT
Course Code-EVS30ICC
Exam Course Code-301

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time: 3 hrs.

Environmental Hazards and Disaster Management:

This paper introduces the students to various environmental hazards, their causes, nature, preparedness and assessment of loss. It teaches them to model hazards and familiarizes them with methods of disaster management.

UNIT I

Concept of hazard, disaster, risk, vulnerability, exposure and response. Distinction between natural hazards and anthropogenic environmental disturbances, Hybrid hazards.

Environmental Hazards: Classification, Causes and Distribution.

UNIT II

Natural Hazards: Geological Hazards: Earthquakes, Volcanoes, Mass-movement; Tsunami.

Hydrological Hazards: Floods, Droughts, Water Quality, Contamination, Arsenic problem,

Cyclones, Hurricanes Atmospheric/Climatic Hazards: Extreme weather events, Global Climatic change.

UNIT III

Man made Hazards: Biophysical Hazards: Frost Hazards in agriculture, epidemics, wildfires

Technological Hazards: Nature and significance. Lessons from Bhopal and Chernobyl disasters.

Modelling of Hazards: Hill slopes and landslides.

UNIT IV

Disasters and Hazard Management: Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; Hazards policies and agencies; Land use classification. Role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Suggested Readings:

Bell. F.G, E & FN Spon, 1999, Geological Hazards: Their Assessment, Avoidance and Mitigation, e Books der ULB Darmstadt.

Burton. I, Kates. R.W and White. G.F, 1993, Environment as Hazard Guilford Press.

Casale. R and Margottini. C. (Ed.), Springer, 2004, Natural Disasters and Sustainable Development

Hewitt. K., 1997, Regions of risk, Longman Press.32

Henry J.G. and Heinke , G.W., 2004, Environmental Science and engineering, Pearson education, Delhi,India.

Keller. Edward A, 1996, Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey

Smith Keith, 2001, Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge.

M.Sc. Environmental Sciences: Semester-3

ENVIRONMENTALPHYSICS

Course Code-EVS302CC

Exam Course Code-302

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Environemtnal Physics:

The paper aims at imparting the physical concept and physical processes in the environment. Knowledge about thermodynacis, energy flow and radiations to the students is the major objective of the paper.

UNIT I

Concept and scope of environmental Physics with respect to human environment; built environment; urban environment; global environment.

UNIT II

Laws of thermodynamics, irreversible thermodynamics and entropy. Wind chill, Hypothermia. Heat balance (steady and transient), Electromagnetic Radiation, Thermal regulation in buildings- Thermal insulation, Thermal conduction effects, Convection effects, Radiation effects, U-values,

UNIT III

Energy use and efficiency in buildings. Energy losses, calculation of energy losses, energy gains. Air regulation in buildings, heat pumps, condensation. Buildings of the future.

UNIT IV

Nano materials: their properties and influence on human health, environment, communication sector and energy. Method of preparation and Applications of nano-materials.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

M.Sc. Environmental Sciences: Semester-3
REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM
Course Code-EVS303CC
Exam Course Code-303

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Remote Sensing and Geographic Information System:

The course provides students with an introduction to the principles and techniques of remote sensing and geographic information systems (GIS) and the application of these techniques to the various aspects of environment including the earth observation and analysis. The students will be able to understand the information embedded in remotely sensed data, its retrieval and geospatial analysis for employability in geospatial domain.

Unit - I

Definition, Introduction and scope of remote sensing. Electromagnetic radiation, atmosphere window, Platforms, Sensors and type of scanning systems. Basic characteristics of sensors; salient features of sensors used in Indian remote sensing satellites.

Unit - II

Aerial photography- vantage point, cameras, Filters and types of films. Elements of visual image interpretation. Multispectral Remote sensing, Microwave Remote sensing,

Unit - III

Digital image and image structure, Image restoration and image and image enhancement. Image classification. Remote sensing application in Forestry, Ecology and Environment, Land use, Agriculture, soils and geology, Disaster management.

Unit- IV

GIS technology and its uses in environmental sciences, Hardware and software requirement for GIS. Conceptual model of spatial information, Conceptual model of non spatial information. GPS.

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. American Society for Photogrammetry and Remote Sensing (1999), *Remote Sensing for the Earth Sciences*, Manual of Remote Sensing, 3rd Ed., Vol. 3, Wiley, New York.
2. Avery, T.E., and G.L. Berlin (1992), *Fundamentals of Remote Sensing and Air Photo Interpretation*, 5th Ed., Macmillan, New York.
3. Bhatia, B. (2008), *Remote Sensing and GIS*, Oxford University Press, New Delhi
4. Chang, Kang-Tsung (2002) *Introduction to Geographic Information Systems*, Tata McGraw Hills Publishing Company Ltd, New Delhi.
5. Chanrda, A.M. and Ghosh S.K. (2006) *Remote Sensing and Geographical Information System*, Narosa Publishing House, New Delhi.
6. Chaunial, D.D. (2016) *Principles of Remote Sensing and Geographical Information System (In Hindi)*, Sharda Pustak Bhawan, Allahabad.
7. Curran, Paul J. (1985), *Principles of Remote Sensing*, Longman, London & New York.
8. Jensen, J.R. (2004), *Remote Sensing of the Environment: An Earth Resource Perspective*, Pearson Education.
9. Joseph, G. (2003), *Fundamentals of Remote Sensing*, Universities Press, Hyderabad.
10. Lo, C.P. and Yeung, K.W. Albert (2009), *Concepts and Techniques of Geographical Information Systems*, PHI Learning Pvt.Ltd., New Delhi.
11. Lillesand, T.M.; Kiefer, R.W.; and Chipman, J.W. (2008), *Remote Sensing and Image Interpretation*, Sixth Edition, Wiley-India, New Delhi.
12. Meenakhi Kumar (2000), *Text book on Remote Sensing*; NCERT, New Delhi.
13. Nag, P. and Kudrat, M. (1998), *Digital Remote Sensing*, Concept Publishing Co. Pvt. Ltd., New Delhi.
14. Nag, Prithvish and Sengupta, Smita (2008), *Introduction to Geographical Information System*, Concept Publishing Co. Pvt. Ltd., New Delhi.
15. Panda, B.C., (2005) *Remote Sensing : Principles and Applications*, Viva Books Pvt. Ltd., New Delhi.
16. Rampal, K.K. (1999), *Handbook of Aerial Photography and Interpretation*, Concept Publishing Co. Pvt. Ltd., New Delhi.
17. Reddy, Anji, M. (2001) *Textbook of Remote Sensing and Geographical Information Systems*, BSP B.S. Publications, Hyderabad.
18. Sabins, F. F. Jr. (1997), *Remote Sensing: Principles and Interpretation*, 3rd Ed., W.H. Freeman and Co., New York.
19. Siddique, M.A. (2006) *Introduction to Geographical Information Systems*, Sharda Pustak Bhawan, Allahabad.
20. Star, J.L.; Estes, J.E. and McGwire, K.C. (1997), *Integration of GIS and Remote Sensing*, Cambridge University Press, London.

M.Sc. Environmental Sciences: Semester-3
ATMOSPHERE AND GLOBAL CLIMATE CHANGE
Course Code-EVS304CC
Exam Course Code-304

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Atmosphere and global climate change:

This paper introduces the student to the development of the Earth's atmosphere, its dynamic nature and variability in terms of the global energy balance. It also deals with elements of the climate, climate change and human impacts on climate initiative policies.

UNIT I

Earth Systems: Atmosphere, Hydrosphere, Lithosphere, Biosphere and their linkage. Earth's geological history and development and evolution of the atmosphere; Gaia Hypothesis. Atmosphere and climate. Basic atmospheric properties, climatic controls. Climatic classifications and variability. Movement in the atmosphere: global scale, regional scale, local scale.

UNIT II

Oceans: General circulation patterns. Air- Sea interaction. Global Energy balance: Source, transfer, distribution. Energy balance of the atmosphere. Wind, stability and turbulence; Monsoons; El Nino, Southern Oscillations, cyclones. Natural climate changes: Records of climate change (glacial cycles, ocean sediments, corals, tree rings).

UNIT III

Human Impacts on climate:(i) Causes and consequences of Global warming: Greenhouse effect; Global and regional trends in greenhouse gas emissions; Sea level rise; role of oceans and forests as carbon sinks (ii) Ozone depletion- stratospheric ozone shield; Ozone hole.

UNIT IV

Impacts of Climate change: Effects on organisms including humans; effects on ecosystems and productivity; species distribution ranges; spread of diseases; Extinction risk for temperature-sensitive species; UV effects Climate change and Policy: Montreal Protocol; Kyoto Protocol; Carbon trading; clean development mechanisms.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Suggested Readings:

Barry, R. G., 2003. Atmosphere, weather and climate. Routledge Press, UK

Critchfield, Howard J., 1998, General climatology, Prentice Hall India Pvt. Ltd., New Delhi.

Firor, J., and J. E. Jacobsen, 2002. The crowded greenhouse: population, climate change and creating a sustainable world. Yale University Press.

Glantz, M. H., 2003. Climate Affairs: a primer. Island Press.

Harvey D., 2000, Climate and Global Climate Change, Prentice Hall.

Kump, L. R., Kasting, J.F., and Carne, R. G., 2004. The Earth System. 3 Ed. Prentice-Hall

M.Sc. Environmental Sciences: Semester-3
ENVIRONMENTAL GEOLOGY
Course Code-EVS305DCEC
Exam Course Code-305

End Semester Exam : 80 marks
Internal Assessment : 20 marks
Total : 100 marks

Time : 3 hrs.

Environmental Geology:

All human activities take place on earth using a large variety of its resources. How do we live here and use these resources, so that not only sustainable society but also life itself is sustained, need the knowledge of the science of the earth (= Geology) for all its citizens. The subject Environmental Geology is an applied one, wherein basic geologic knowledge is used to maximize the utilization of all natural resources, minimize their degradation as well as minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.

UNIT – I

Earth processes, Geological cycle, Tectonic cycle, Rock cycle, Hydrological cycle, Biogeochemical cycles, concept of residence time and rates of natural cycles.

UNIT - II

Catastrophic geological hazards, Natural hazards: Earthquakes- causes, effects, distribution and prediction; Volcanoes-types, products of volcanic eruption and its environmental impact; Landslide slope stability, factors affecting slope stability, causes and prevention of landslides; brief note on tsunami.

UNIT - III

River flooding- causes, nature and frequency of floods. Landslides- causes, intensity and magnitude. Volcanism nature extent and causes, Volcanism and climate. Avalanches causes and effects.

UNIT - IV

Mineral and human use, geology of mineral resources, Physical properties of minerals; brief overview of formation, forms, textures, structures, classification of igneous, sedimentary and metamorphic rocks.

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Keller E.A. (2010), *Environmental geology*, 9th edition, Pearson
2. Geology of India, *National book trust series*.
3. Tank R. W. (1973), *Environmental Geology*, Oxford University Press.
4. Valdiya K. S.(1987), *Environmental Geology: Indian Context*, Tata McGraw-Hill Pub. Co
5. Bell, F.G. (1983), *Fundamentals of Engineering Geology*, Butterworths.
6. Krynine, D.P. Judd, W.P. (1957), *Principles of Engineering Geology*, McGraw Hill.
7. Burbank, D.W. & Anderson, R.S. (2012). *Tectonic Geomorphology*. Wiley and Blackwell Publications, a John Wiley and Sons, Ltd.
8. Duggal, K.N. and Soni, J.P. (1996). *Elements of water resource engineering*, New Age International Publisher.
9. Guitierrez, M. (2013), *Geomorphology*, CRC press.
10. Huddart, D. & Stot, T. (2010), *Earth Environment-Past, Present and future*, Wiley 24 and Blackwell Publications, A John Wiley and Sons, Ltd.

M.Sc. Environmental Sciences: Semester-3
ENVIRONMENTAL ETHICS AND PHILOSOPHY
Course Code-EVS306DCEC
Exam Course Code-306

End Semester Exam : 80 marks
Internal Assessment : 20 marks
Total : 100 marks

Time : 3 hrs.

ENVIRONMENTAL ETHICS AND PHILOSOPHY

The main objective of this course will be to familiarise the students with the broad theories and parameters of environmental philosophy, including issues of animal rights, human rights and wilderness ideas. The effort will be to look at the philosophical basis of current conservation theories and competing views of environmentalism.

UNIT I

An Introduction to Environmental Ethics and Philosophy: Ethics in society; Environmental Consequences; Responsibility for Environmental Degradation

UNIT II

Theories of Environmental Ethics and Philosophy: Different types of schools of thought vis-à-vis nature and environmental management. Values in modernity, anti-modernity, eastern and western cultures, nature and religion etc. Eco Centric Theories of Nature: Deep ecology and animal rights theories, environmental rights, environmental racism.

UNIT III

Cross-cultural views on Nature: The relationship between humans, nature and adaptation. Theoretical frameworks of cultural and social ecology; debates on culture/nature divide. Environment and Business Ethics: Foundations of Environmental Ethics for Business, Corporate Environmental Ethics, Environmental Disclosure, Social and Ethical Issues for Sustainable Development, Business Ethics and Corporate Environmental Performance.

UNIT IV

Environmental Ethics and Issues of National and International Governance: changing nature of environmental ethics in relation to international and national paradigms of environmental governance. Resource consumption patterns and the need for equitable utilization; Equity disparity in the northern and southern countries; Urban – rural equity issues; The conservation ethics and traditional value system of India.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Suggested Readings:

- Aggarwal Anil & Narain Sunita, 1991, Global warming in an unequal world: A case of Environmental colonialism, Centre for Science & Environment.
- Cooper, D.E. & Palmer. J.A., (Ed.), 1992, The Environment in question: Ethics & Global Issues, London, Routledge.
- Des Jardius, J.R., 2001, Environmental Ethics: An invitation to Environmental philosophy (3rd Ed.), Wadsworth Publ., Belmont, California.
- Grim. John. A., 2001, Indigenous Traditions and Ecology (Ed.), Harvard University Press.
- Lesourd, J.B. and Schilizzi, S.G. M., 2001, The Environment in Corporate Management: New Directions and Economic Insights, Edward Elgar, UK.
- Vanderveer, D.C.P. and Vanderveer, D., 2002, The Environmental Ethics and policy book: Philosophy, Ecology, Economics (3rd Ed.), Wadsworth publishing, California.

M.Sc. Environmental Sciences: Semester-3
HYDROLOGY AND WATER RESOURCES
Course Code-EVS307OEC
Exam Course Code-307

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Hydrology and water resources:

The course introduces the student to the hydrologic cycle and various characteristics of surface and groundwater resources including different techniques of water management. It also introduces them to basic analytical methods to quantify water quality and determine hydrological parameters.

UNIT I

Introduction: The hydrologic cycle; Structure and properties of water, Inventory of Earth's water, quality and quantity. Limits of cations and anions in portable water including fluoride and arsenic, phosphate, nitrate and heavy metals. Application of isotopes in hydrology. Hydrogeology of India.

UNIT II

Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff, Drainage basin. Groundwater resources: rock properties affecting ground water, vertical distribution of ground water, zone of saturation. Darcy's law: permeability, transmissivity and storage coefficient. Viscous character of groundwater flow. Geologic formations as aquifers, type of aquifers. Distribution of water - local, regional and global. Ground water exploration.

UNIT III

Environmental Influences on water resources: surface and groundwater resources of arid and semiarid regions, Snowmelt hydrology from glaciers, fluctuations due to urbanization, Evapo-transpiration and tides. Recent development in surface and groundwater resources monitoring and assessing processes. Salinity ingress in ground water. Water logging and soil salinity-conjunctive use of surface water and ground water.

UNIT IV

Water resource management: Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment. Wetland and riparian management; forest management on water resources. Environmental issues: River linking debate. Dams and their impacts.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Suggested Readings:

- Aggarwal, A., 1991, Floods, Floodplains and Environmental Myths. Centre for Science and Environment, New Delhi.
- Andrew D. Ward and Stanley Trimble, 2004, 2ndEd., Environmental Hydrology, Lewis Publishers.
- Karant, K.R.C., 1988, Ground Water: Exploration, Assessment and Development. Tata-McgrawHill, New Delhi.
- Mahajan, G., 1989, Evaluation and Development of Groundwater. Ashish Publishing House, New Delhi.
- Rao, K.L., 1982, India's water wealth. Orient Longman, Delhi.
- Subramaniam V., 2002, Text Book of Environmental Science, Narosa Publishing House, Delhi.
- Timothy, Davie, 2003, Fundamentals of Hydrology. Rowledge, Taylor and Francis Group, U.K.
- Todd, D.K., 2004, Groundwater Hydrology, John Wiley & Sons Inc.
- Vijay P. Singh, 1995, Environmental Hydrology. Kluwer Academic Publications, The Netherlands.
- Wright. R.T and Nebel. B.J., 2002, Environmental Science: toward a sustainable future, Prentice Hall India Ltd, 8th Edition.

M.Sc. Environmental Sciences: Semester-3

PRACTICALS –LAB COURSE-I

Course Code-EVS308CC

Exam Course Code-308

Max. Marks : 50

Time : 4 Hours

Distribution of Marks :

Lab work test : 30

Record on labwork : 10

Viva Voce : 10

COURSE OBJECTIVES: The course aims at the training of the students in the laboratory for identification and characterization of different types of solid waste. The students will also learn various methods to analyze waste physical and chemical characteristics. A field exposure for solid waste management will also be imparted.

List of Experiments

1. To determine calorific value by calculation, Bomb Calorimeter.
2. To determine physical composition of solid wastes.
3. To determine moisture content, pH and conductivity of solid waste sample.
4. To determine NPK in compost and vermicompost.
5. To determine C/N ratio.
6. A visit to normal and secured landfill site, biological composting/vermicomposting units in the city.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

Recommended Readings:

1. De, A.K., (2000), *Environmental Chemistry*. New Age International (P) Ltd. Publishers, New Delhi.
2. Hillel, D., (1982) *Introduction to Soil Physics*, Academic Press, New York..
3. Solid Waste Management Manual CPCB, New Delhi.
4. Letcher, Trevor M. (Ed.) (2011) *Waste: A handbook for management*, Academic Press London.
5. Williams, Paul T. (2013) *Waste treatment and disposal*, John Wiley Publishers.

M.Sc. Environmental Sciences: Semester-3
PRACTICALS –LAB COURSE-II
Course Code-EVS309CC
Exam Course Code-309

Max. Marks : 50

Time : 4 Hours

Distribution of Marks :

Lab work test : 30

Record on labwork : 10

Viva Voce : 10

COURSE OBJECTIVES: The course aims at the training of the students in the laboratory for identification and characterization of different types of solid waste. The students will also learn various methods to analyze waste physical and chemical characteristics. A field exposure for solid waste management will also be imparted.

List of Experiments

Practicals:

Preparation of Hazard Zonation map of India for land slides, earthquakes, floods etc.

Earthquake-loss estimation using remote sensing and GIS

Preparation of master plan for any Environmental Hazard mitigation

Practicals:

Estimation of physico-chemical properties of water: Turbidity, Light penetration, Conductivity, Total

suspended solids, Alkalinity, Hardness, Dissolved oxygen, BOD, COD, pH, Eh,

Analysis of water quality on Tri-linear diagram,

Evaluation of hydrologic parameters; catchment delineation and water balance. Hydrograph analysis.

SEMESTER-IV

M.Sc. Environmental Sciences: Semester -4
ENVIRONMENTAL POLICIES & LAWS
Course Code-EVS401CC
Exam Course Code-401

End Semester Exam : 80 marks
Internal Assessment : 20 marks
Total : 100 marks

Time : 3 hrs.

Environmental Policies and Laws:

Environmental law is that branch of law for planetary house keeping, protecting the planet and its people from activities that upset the earth and its life-sustaining capacities. This paper aims to understand and apply a range of regulatory instruments to preserve and protect the environment. It also emphasizes on identifying the strengths and weaknesses in law and its enforcement and develops strategies to overcome the same.

UNIT - I

Nature of Environmental Policies; Stockholm Conference(1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Need of international agreements and treaties; Johannesburg treaty; GAAT and Environment; CITES; Montreal Protocol. Basel convention

UNIT – II

Environmental policy resolution, legislation, public policy strategies in pollution control. Public liability Insurance Act. 1991. Provision of constitution of India regarding environment (article 48 A & 51A). Scheme of labeling of environmentally friendly products (ecomark).

UNIT - III

Wild life Protection act, 1972 amended 2002. Forest conservation act, 1980. Indian forest act 1927 Air (prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. Motor vehicle act, 1988, The environment (protection) Act, 1986, rules 1986. The water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975.

UNIT – IV

Concept and need of public interest litigation; Jurisdiction of National Green Tribunal; Need of CRZ rules for regulation the activities in coastal zone. Rules regarding solid waste, hazardous material, e-waste, flyash, Biomedical waste, Plastic waste

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Diwaa. P. (2002), *Environmental administration & law*, 2nd edition, Deep & Deep Publications.
2. Saxena, K.D. (1993), *Environmental planning, policies & programs in India*, Shipra Publications.
3. Jain, S. and Jain V., *Environmental Laws in India*, The Lawyers home, Indore.
4. Divan S. and Rosencranz A. (2002), *Environmental law and policy in India: cases, materials and statutes*, Oxford University Press
5. Vig, N. J. and Axelrod R. S. (1999), *The Global Environment: Institutions, Law and Policy*, EarthScan London.
6. James C., Werksman H., and Roderick P. (2006), *Improving compliance with International Environmental Law*, Earth Scan London.
7. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
8. Anti – Pollution Acts (3) and Commentaries published theorem.
9. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].
10. Leelakrishnan, P. (2016), *Environmental law in India*, 4th edition Lexis Nexis;
11. Holmes, G., Singh B.R., and Theodore ,L., *Environmental management and technology*

M.Sc. Environmental Sciences: Semester-4
SOLID AND HAZARDOUS WASTE MANAGEMENT
Course Code-EVS402CC
Exam Course Code-402

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Solid and Hazardous Waste Management:

This paper introduces the students to various environmental hazards, their causes, nature, preparedness and assessment of loss. It teaches them to model hazards and familiarizes them with methods of disaster management.

Unit – I

Sources, Generation, Classification & Composition of solid wastes. Generation rates – Factors affecting generation rates. Onsite handling, Storage and Processing of solid wastes - necessary equipment.

Unit - II

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit - III

Biomedical Waste Management 2016. Hazardous Waste Management & Handling rules, 2016(amendments)

Unit- IV

Solid waste management methods –Rules 2016, Sanitary land filling, Recycling, Composting, Vermi-composting, incineration, energy recovery from organic waste, Fly ash generation & utilization.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Solid Waste Management CPCB. New Delhi.
2. Trivedi R.K. & Kumar A.(1998),*Ecotechnology for pollution control & environmental management*, Enviro Media, India
3. Nathanson J.A.(2016),*Basic Environmental Technology*, Sixth edition, Pearson Education India
4. Manual on Municipal 1 Solid waste Management (2000), CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi.
5. Agarwal,S.K. (2005). *Green Management*, APH Publishing corporation, New Delhi.
6. Agarwal,S.K. (2005). *Wealth from waste*, APH Publishing corporation, New Delhi
7. Bhatia,S.C.(2007). *Solid and Hazardous Waste Management*. Atlantic Publishers and Distributors, New Delhi
8. Bide,A.D. and SundaresanR.R.. (2001). *Solid Waste Management: Collection, processing and disposal*. INSDOC, New Delhi
9. Khan,M.K. (2004). *Hospital waste Management: Principles and guidelines*, Kanishka Publishers, New Delhi.
10. Liu,D.H.F. and Liptak R.G. (2000). *Hazardous waste and solid waste*. Lewis Publishers, New York.
11. Metcalf and Eddy. (1991). *Waste Water Engineering – Treatment, Disposal and Reuse*. McGraw Hill International Edition, New York.

M.Sc. Environmental Sciences: Semester -4
ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE DEVELOPMENT
Course Code-EVS403CC
Exam Course Code-403

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

Environmental management for sustainable development:

The paper deals with the human dimension of development and environment. It aims to provide adequate insight on management of natural resources by imparting training in tools and methodologies of ecological and environmental economics.

UNIT - I

Definition of sustainability – Environmental, Economical and Social dimensions of sustainability. Sustainable agriculture, Sustainable forest management, Industrial waste management, Water resource management.

UNIT - II

Global, Regional and Local environmental issues, Population growth, Urbanization, Industrialization, Globalization Social insecurity, Resource Degradation, Climate Change, Desertification, Greenhouse gases.

UNIT – III

Sustainable agriculture, Water and sanitation, Biodiversity conservation, Urbanization and Sustainable Cities, Green Buildings, Sustainable Consumption and Production, Sustainable Energy, Climate Change, Mitigation and Adaptation .

UNIT – IV

Governments and International Agreements for Sustainable Development, Commission on Sustainable Development (1992), Reducing Emissions from Deforestation and Forest Degradation (redd), The Man and the Biosphere Programme (MAB), United Nations Conference on the Human Environment (1972) Brundtland Commission (1983) The Rio Declaration on Environment and Development (1992), Kyoto Protocol (1997).

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Clayton, B. D. and Bass, S (2002).*Sustainable Development Strategies- a resource book*, Earthscan Publications Ltd, London.
2. Barrow,C.(2006) ,*Environmental Management and Development*, 2nd edition.
3. Elliott,J A. (2006) ,*An Introduction to Sustainable Development*, 3rd edition.
4. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. (2007), .*An Introduction to Sustainable Development*. Earthscan.
5. Oberai, A.S. (1987),*Migration, Urbanization and Development*, International Labour Office, Geneva
6. Botkin, Daniel B. and Keller, Edward A (2007).*Environmental Science: Earth as a Living Planet*. 6th ed. John Wiley & Sons, USA.
7. Cunningham, W. P. and Cunningham, M. A. (2004) *Principles of Environment Science. Enquiry and Applications*. 2nd ed. Tata McGraw Hill, New Delhi.
8. Rajagopalan, R., (2008)*Environmental Studies: From crisis to cure*, Oxford University Press, New Delhi.
9. Richards,I. S.,(2008)*Principles and Practice of Toxicology in Public Health*, Jones and Bartlett Publishers, London.
10. Singh, J.S., Singh, S.P. and GuptaS.R., (2006) *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi, India.
11. UNEP. Global Environment Outlook 3. Geneva: UNEP, Global Resource Information Division.(2003).
12. World Commission on Environment and Development (WCED): Our Common Future, (1987),Oxford University Press, London
13. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
14. Tiwari, R. K. (2007), *Global Environmental Policies*. A B D Publishers..
15. Singh, T. (2006),*Disaster management Approaches and Strategies*, Akansha Publishing House, New Delhi.
16. Harris,F. (2004), *Global Environmental Issues*, Wiley & Sons, Inc., USA.

M.Sc. Environmental Sciences: Semester-3
ENVIRONMENTAL BIOTECHNOLOGY

Course Code-EVS404CC

Exam Course Code-404

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

Environmental Biotechnology:

The course is aimed at providing comprehensive training in investigating the natural environment and to develop potential solutions to remedy its damage using chemical, biochemical and molecular technologies.

UNIT - I

Classification, characteristics, occurrence, distribution and ecological importance of microorganism. Role of microbes in biogeochemical cycles - Carbon cycle; Sulphur cycle; Nitrogen cycle and Phosphorus cycle. Detection of microbial toxins. Elementary information of gene transfer, brief account of cloning vehicles and recombinant DNA technology and its applications.

UNIT - II

Environmental monitoring-environmental impacts and their assessments using bioindicators, biomarkers, biosensors and toxicity testing, rDNA technology, Conservation strategies.

UNIT - III

Bioremediation principles, Strategies and techniques of bioremediation-in situ and ex situ Bioremediation of metals, Phytoremediation, GMOs and their impact on bioremediations, Bioaugmentation and biostimulation, Solid phase and slurry phase bioremediation; Biological Filtration Processes for Decontamination of Air Stream; Biofiltration; Biotrickling Filtration; Bioscrubbers; Use of microbes for Heavy metal detoxification.

UNIT - IV

Principles of biodegradation and mechanism of detoxification, Biodegradation of detergent, pesticide, lignin, hydrocarbon and dyes. Microbiological management of hazardous waste and wastelands. Biotechnological approaches and steps involved in conventional and advanced treatment technology. Release of genetically engineered microbes and environmental risk.

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Rittman, B., McCarty P. L. (2000). *Environmental Biotechnology: Principles and Applications*, 2nd Edition, McGraw-Hill,
2. Alexander, M., (1999), *Biodegradation and Bioremediation*, 2nd Edition, Academic Press,
3. Pelczar, M. J., Chan, E.C.S (1993), *Microbiology*, McGraw Hill Education Private limited , New Delhi.
4. Chatterji A.K. (2011), *Introduction to Environmental biotechnology*, PHI Learning private limited, New Delhi.
5. Evano, G.H. and Furlong, J.C. (2004), *Environmental Biotechnology – Theory and Application*, John Wiley and Sons, USA.
6. Jjemba, P.K. (2004), *Environmental Microbiology – Theory and Application*. Science Pub. Inc., USA.
7. Olguin, C. J., Sanchez, G., Hernandez E. (2000), *Environmental Biotechnology and Cleaner Bioprocesses*. Taylor & Francis.
8. Pepper, I.L. and Gerba C.P. (2005), *Environmental Microbiology - Laboratory Manual*. Elsevier, USA.
9. Ratledge, C. and Kristiansen, B. (2002), *Basic Biotechnology*. 2nd ed. Cambridge University Press, Cambridge, UK.
10. Rittman, B. and McCarty, P. L. (2000), *Environmental Biotechnology: Principles and Applications*, 2nd edition. Tata McGraw-Hill, USA.
11. Rittmann, B.E. and McCarty, P.L. (2001), *Environmental Biotechnology – Theory and Application*. McGraw Hill, USA.

M.Sc. Environmental Sciences: Semester -4
ENVIRONMENTAL ISSUES IN INDIA
Course Code-EVS405DCEC
Exam Course Code-405

End Semester Exam : 80 marks
Internal Assessment : 20 marks
Total : 100 marks

Time : 3 hrs.

Environmental Issues in India:

Unit-I

Environment: concept and components of environment; abiotic & biotic types of environment; Biodiversity and Biosphere Reserve.

Unit-II

Environmental Hazards: Earthquakes, Volcanoes, Tsunamis, Floods, Droughts and famines- Causes, consequences and measures;

Unit-III

Environmental Pollution- meaning, types, sources, causes and effects of environmental pollution with special reference to air pollution, water pollution & noise pollution. Environmental Legislation on air and water pollution in India.

Unit-IV

Climate Change: Global warming, Green house effect; Ozone depletion; Acid Rain; Urban smog.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Anderson J.M. (1981), *Ecology for Environmental Science : Biosphere, Ecosystems and Man*, Arnold, London.
2. Botkin, D.B., Keller, E.A. (2007), *Environmental Science: Earth as a Living Planet*, John Wiley and Sons, New York.
3. Goudie, A, (1984), *The Nature of the Environment*, Oxford Katerpring Co. Ltd.
4. McKinney, M.L., Schoch, R.M. (2003), *Environmental Science: Systems and Solutions*, Jones & Bartlett Learning.
5. Miller, G.T, Spoolman, Scott (2011), *Environmental Science*. Brooks Cloe, London.
6. Odum, E.P. (1971), *Fundamental of Ecology*, W.B. Sanders, Philadelphia.
7. UNEP (2007), *Global Environment Outlook: GEO4: Environment For Development*, United Nations Environment Programme.
8. Mandal,F. B. and Nandi,N. C. (2013),*Biodiversity: Concepts, Conservation and Biofuture*, Asian Books,
9. Jorgensen, Sven Erik.,(2008) *Encyclopedia of Ecology*. Vol 1-5. Elsevier Publishers. Netherlands.
10. Strahler, A.N. (1996). *An Introduction to Physical Geography*. John Wiley & Sons, UK.
11. Lal, D.S. (2011). *Climatology*, Sharda Pustak.

M.Sc. Environmental Sciences: Semester - 4

ENVIRONMENTAL AND RESOURCE ECONOMICS

Course Code-EVS406DCEC

Exam Course Code-406

Max. Marks : 100

Distribution of Marks :

End Semester Exam : 80

Internal Assessment : 20

Time : 3 Hours

ENVIRONMENTAL AND RESOURCE ECONOMICS

Economics & ecology must be completely integrated in decision making & law making processes and there should be an effort to increase understanding of intriguing policy problems. Environmental and resource economics makes use of ideas and tools developed in other branches of economics to make significant contribution to valuation techniques, design of policy instruments for pollution control and management of commons.

UNIT I

Introduction: Overview of Central Issues; Refresher on Supply and Demand
Basics of Welfare Economics: Producer and Consumer Surplus, Market failure, Externalities, Public Goods, Pareto Optimality Cost-Benefit Analysis and Valuation: Discounting, Principles of

UNIT II

Cost-Benefit Analysis, Estimation of Costs and Benefits, Techniques of Valuation Non-Renewable Resources: Economics of Fuels and Minerals, Hotelling's Rule and Extensions, Taxation, Recycling, Waste Management Renewable Resources: Economics of water use,

UNIT III

Management of Fisheries and Forests Pollution Control: Policies for Controlling Air and Water pollution, Disposal of Toxic and Hazardous Waste-Standards vs. Emissions Charges
Regional and Global Concerns: Acid rain, Ozone depletion, Greenhouse Effect, WTO and environment, Natural Disaster Management.

UNIT IV

Growth, Resources and the Environment: Resource Scarcity, Poverty, Sustainable Development, Foreign Aid.

Note:The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Suggested readings:

Baumol, W.J. and Oates, W.E., 1988, *The Theory of Environmental Policy* Cambridge University Press.

Bhattacharya, R.N. (Ed.), 2001, *Environmental Economics: An Indian Perspective*, O.U.P.

Bromley, D.W. (Ed.), 1995, *Handbook of Environmental Economics*, Blackwell.

Kadekodi, G.K., (Ed.), 2004, *Environmental Economics & Practice*, O.U.P.

Kolstad, Charles, 2000, *Environmental Economics*, Oxford University Press.

Tietenberg, Tom, 2003, *Environmental and Natural Resource Economics* (sixth edition) Pearson Education.

M.Sc. Environmental Sciences: Semester - 4

LABORATORY WORK I

Course Code-EVS407

Exam Course Code-407

Max. Marks : 100

Time : 4 Hours

Distribution of Marks :

Lab work test : 40

Record on lab-work : 10

Viva Voce : 10

Laboratory work/Project work:

1. To determine Biological Oxygen Demand (BOD)of waste water sample.
2. To determine chemical oxygen demand (COD) of waste water sample.
3. Nitrates determination
4. Sulphates determination
5. Diatoms determination

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

M.Sc. Environmental Sciences: Semester - 4

LABORATORY WORK II

Course Code-EVS408

Exam Course Code-408

Max. Marks : 50

Time : 4 Hours

Distribution of Marks :

Lab work test : 30

Record on lab-work : 10

Viva Voce : 10

Laboratory work/Project work:

1. To determine the amount of oil and grease content present in the given water sample.
2. To determine phosphate content in a given sample of water.
3. To determine the total chlorine (residual) by Iodometric method.
4. To determine the minimum dose of a coagulant required to coagulate a given sample .
5. Preparation of nutrient media for microbial growth.
6. To slide the growth of bacterial colonies of Environmental Samples (Air/Water).
7. To determine the effect of antibiotics on bacterial growth.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

ADDITIONAL

5. Environmental Physics ES - 205

Concept and scope of environmental Physics with respect to human environment; built environment; urban environment; global environment. Laws of thermodynamics, irreversible thermodynamics and entropy. Wind chill, Hypothermia. Heat balance (steady and transient), Electromagnetic Radiation, Thermal regulation in buildings- Thermal insulation, Thermal conduction effects, Convection effects, Radiation effects, U-values, Energy use and efficiency in buildings. Energy losses, calculation of energy losses, energy gains. Air regulation in buildings, heat pumps, condensation. Buildings of the future. Nano materials: their properties and influence on human health, environment, communication sector and energy. Method of preparation and Applications of nano materials.

M.Sc. Environmental Science: Semester - 4
POPULATION EXPLOSION & SUSTAINABLE DEVELOPMENT

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

UNIT - I

Growth and distribution of population in the world and India; concepts of over population, under population and optimum population.

Migration; Causes and consequences of migration; Demographic attributes: sex-ratio, age structure, literacy rate, work-force, dependency ratio, longevity.

UNIT - II

Environmental issues and crisis: Environmental hazards, Environmental pollution; Environmental degradation; Deforestation, desertification and soil erosion; Energy crisis; Resource degradation.

UNIT – III

Sustainable Development: concept of Sustainable Development; Global and regional dimensions of Sustainable Development. Concept of sustainable urban development; Sustainable Cities; urban sprawl.

UNIT – IV

Governments and International Agreements for Sustainable Development, Commission on Sustainable Development (1992), United Nations Conference on the Human Environment (1972) Brundtland Commission (1983) The Rio Declaration on Environment and Development (1992).

Note: The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks

Recommended Readings:

16. Barrow, C., (2006), *Environmental Management and Development*, 2nd edition
17. Elliott, J. A. (2006), *An Introduction to Sustainable Development*, 3rd edition
18. Oberai, A.S. (1987), *Migration, Urbanization and Development*, International Labour Office, Geneva
19. United Nations, (1983), *Determinants and Consequences of Population Trends*, Vol 1, UN, New York, Chapter-VI.

20. Bhende, A., (1996), *Principles of Population Studies*, Seventh Edition, Himalaya Publishing House, Bombay.
21. Botkin, D. B. and Keller, E. A.,(2007). *Environmental Science: Earth as a Living Planet*, 6th ed. John Wiley & Sons, USA.
22. Cunningham, W. P. and Cunningham, M. A (2004), *Principles of Environment Science. Enquiry and Applications*, 2nd ed. Tata McGraw Hill, New Delhi.
23. Rajagopalan, R., (2008)*Environmental Studies: From crisis to cure*, Oxford University Press, New Delhi.
24. Richards, I. S.(2008),*Principles and Practice of Toxicology in Public Health*, Jones and Bartlett Publishers, London.
25. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology (2006), *Environment and Resource Conservation*, Anamaya Publishers, New Delhi, India.
26. World Commission on Environment and Development (WCED): *Our Common Future*, (1987), Oxford University Press, London..
27. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
28. Tiwari, R. K., (2007), *Global Environmental Policies*, A B D Publisher.
29. Singh T. (2006), *Disaster management Approaches and Strategies*, Akansha Publishing House, New Delhi.
30. Harris,F. (2004), *Global Environmental Issues*,Wiley&Sons, Inc., USA.

Solid Waste Management

Unit – I

Sources, Generation, Classification & Composition of solid wastes. Generation rates – Factors affecting generation rates. Onsite handling, Storage and Processing of solid wastes - necessary equipments.

Unit - II

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit - III

Hospital Waste Management. Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments)

Unit- IV

Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermicomposting, incineration, energy recovery from organic waste, Fly ash generation & utilization.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

12. Solid Waste Management CPCB. New Delhi.
13. Trivedi R.K. & Kumar A.(1998),*Ecotechnology for pollution control & environmental management*, Enviro Media, India
14. Nathanson J.A.(2016),*Basic Environmental Technology*, Sixth edition, Pearson Education India
15. Manual on Municipal 1 Solid waste Management (2000), CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi.
16. Agarwal,S.K. (2005). *Green Management*, APH Publishing corporation, New Delhi.
17. Agarwal,S.K. (2005). *Wealth from waste*, APH Publishing corporation, New Delhi
18. Bhatia,S.C.(2007). *Solid and Hazardous Waste Management*. Atlantic Publishers and Distributors, New Delhi
19. Bide,A.D. and SundaresanR.R.. (2001). *Solid Waste Management: Collection, processing and disposal*. INSDOC, New Delhi
20. Khan,M.K. (2004). *Hospital waste Management: Principles and guidelines*, Kanishka Publishers, New Delhi.
21. Liu,D.H.F. and Liptak R.G. (2000). *Hazardous waste and solid waste*. Lewis Publishers, New York.
22. Metcalf and Eddy. (1991). *Waste Water Engineering – Treatment, Disposal and Reuse*. McGraw Hill International Edition, New York.

M.Sc. Environmental Science: Semester-2
ENVIRONMENTAL GEOLOGY

End Semester Exam: 80 marks
Internal Assessment : 20 marks
Total: 100 marks

Time: 3 hrs.

UNIT – I

Earth processes, Geological cycle, Tectonic cycle, Rock cycle, Hydrological cycle, Biogeochemical cycles, concept of residence time and rates of natural cycles.

UNIT - II

Catastrophic geological hazards, Natural hazards: Earthquakes- causes, effects, distribution and prediction; Volcanoes-types, products of volcanic eruption and its environmental impact; Landslide slope stability, factors affecting slope stability, causes and prevention of landslides; brief note on tsunami.

UNIT - III

River flooding- causes, nature and frequency of floods. Landslides- causes, intensity and magnitude. Volcanism nature extent and causes, Volcanism and climate. Avalanches causes and effects.

UNIT - IV

Mineral and human use, geology of mineral resources, Physical properties of minerals; brief overview of formation, forms, textures, structures, classification of igneous, sedimentary and metamorphic rocks.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

11. Keller E.A. (2010), *Environmental geology*, 9th edition, Pearson
12. Geology of India, *National book trust series*.
13. Tank R. W. (1973), *Environmental Geology*, Oxford University Press.
14. Valdiya K. S.(1987), *Environmental Geology: Indian Context*, Tata McGraw-Hill Pub. Co
15. Bell, F.G. (1983), *Fundamentals of Engineering Geology*, Butterworths.
16. Krynine, D.P. Judd, W.P. (1957), *Principles of Engineering Geology*, McGraw Hill.
17. Burbank, D.W. & Anderson, R.S. (2012). *Tectonic Geomorphology*. Wiley and Blackwell Publications, a John Wiley and Sons, Ltd.
18. Duggal, K.N. and Soni, J.P. (1996). *Elements of water resource engineering*, New Age International Publisher.
19. Guitierrez, M. (2013), *Geomorphology*, CRC press.
20. Huddart, D. & Stot, T. (2010), *Earth Environment-Past, Present and future*, Wiley 24 and Blackwell Publications, A John Wiley and Sons, Ltd.

M.Sc. Environmental Science: Semester-2
RESOURCE MANAGEMENT

End Semester Exam: 80 marks
Internal Assessment: 20 marks
Total: 100 marks

Time: 3 hrs.

Unit - I

Resource management meaning & concept, management of rangelands & watersheds, management of Agricultural system.

Unit - II

Management of waste resources, Management of forests, effects of deforestation. Management of fresh water ecosystem conservation strategies for nonrenewable energy resources.

Unit - III

Wildlife Management & conservation efforts for threatened species, Water Management, Ganga Action Plan, Yamuna Action Plan, Environmental priorities in India.

Unit- IV

Reclamation & Management of waste lands, soil erosion, soil conservation, rural planning & land use pattern. Sustainable development, urban planning for India, Landuse policy for India.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Miller T.J., (2017), *Living of environment* , 19 edition, Brooks Cole
2. Ramade, (1984), *Ecology of Natural resources*, Wiley-Blackwell
3. Cunningham Saigo (2001), *Environmental Science*, McGraw-Hill
4. Singh J.S. (1993), *Restoration of degraded lands*, Rastogi Publications
5. Morgen, M.D. Morgen J.M. and Wiersima J.H. (1993), *Environmental Science : Managing Physical and Biological Resources* Wm C Brown Publishers London.
6. Owen, O.S and Chiras D.D., (1992), *Resource Conservation: An Ecoogical Approach*. Macmillan Publishing Company, New York.
7. Tyler Miller Jr. G. (1990), *Living in the Environment*. Wadsworth Publishing Company, Belmont California.
8. Cunningham. W.P., (1994), *Understanding Our Environmental : An Introduction* W.C. Brown Publishers, Oxford.
9. Singh J.S., (1993), *Restoration of degraded lands*, Rastogi Publications, Meerut.
10. Singh J.S., Singh S.P. and Gupta S.R., (2006), *Ecology Environment and Resource Conservation*, Anamaya Publishers, New Delhi.

Environmental Chemistry

UNIT - I

Stoichiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base. reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.

UNIT - II

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo chemical and photochemical reactions in the atmosphere.

UNIT - III

First law of thermodynamics, enthalpy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, third law of thermodynamics.

UNIT - IV

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D. Water treatment: Sedimentation, Coagulation, Filtration, tertiary and advanced treatment. Inorganic and organic components of soil, nitrogen pathways and NPK in soils.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Sodhi G.S. (2008), Environmental Chemistry, Narosa
2. Sharma and Kaur (2014), Environmental Chemistry, Krishan Prakashan
3. Arnikar. H.J (1995). *Essentials of Nuclear Chemistry*. New Age International, New Delhi.
4. Baird, C and Cann, M (2005). *Environmental Chemistry*. W.H. Freeman and Company, New York (Pub).
5. Dara. S.S. (1993). *A Text Book of Environmental Chemistry and Pollution Control*. S.

Chand, New Delhi.

6. Hamir S. Rathor. (2012). *Pesticides: Evaluation of Environmental Pollution*, CRC Press
7. Lenihan, J.M.A and Fletcher W.W. (1976). *Energy resources and the Environment*. Academic Press.
8. Manahan.S.E.(1999). *Environmental Chemistry*. Lewis Publishers.USA.
9. Santra.S.C.(2004). *Environmental Sciences*. New Central Book Agency, Kolkata.
10. Thomous S. Spiro and William M. Stiglicini, (2002). *Chemistry of the Environment*, Prentice Hall of India Pvt. Ltd

M.Sc. Environmental Science: Semester-3
BIostatistics and Environmental Modelling

End Semester Exam: 80 marks

Internal Assessment: 20 marks

Total: 100 marks

Time: 3 hrs.

UNIT - I

Measurement of central tendency - mean (Geometric and Harmonic), median, mode, Measurement of dispersion moments, standard deviation, skewness and kurtosis. Correlation and linear regression of one independent variable, Basic laws and concepts of probability

UNIT - II

Definition of random variable, density function, Basic concepts of binomial and normal distributions. Sampling measurement and distribution of attributes, matrices and simultaneous linear equations, tests of hypothesis and significance.

UNIT - III

Role of modelling in environmental sciences, Model classification deterministic models, stochastic models, steady state models, dynamic models. Simple microbial growth kinetics, Monod equation.

UNIT - IV

Models of population growth and interactions LotkaVolterra model, Leslies matrix model, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

1. Walpole, R. and Myers R. (1993), *Statistics for Engineers and Scientists*, 5th edn. MacMillan, N.Y.
2. Wayne, R. Ott (1995), *Environmental Statistics and Data Analysis*, CRC Press.
3. Manly (2001) *Statistics for environmental science and management*, Chapman and Hall / CRC.
4. Ramsay and Schafer (1997). *The Statistical Sleuth*, Duxbury Press.
5. Bailey, N.T.J. (1994), *Statistical Methods in Biology*. 3rd ed. Cambridge University Press, Cambridge, UK.
6. Banerjee, P.K.(2004) *Introduction to Biostatistics*. S. Chand and Co., New Delhi.
7. Central Statistical Organization. Compendium of Environmental Statistics India (2003). Ministry of Statistics & Programme implementation. GOI, New Delhi
8. Gardiner, W.P. (1997), *Statistics for biosciences*. Prentice hall, Hamel Hempstead.
9. Gerstman, B.B. (2008) *Basic Biostatistics – Statistics for Public Health Practice*. Janes and Bartlett Pub., U.K..
10. Goodchild, M. F., Parks, B. O., Steyaert, L. T. (1993) *Environmental Modeling with GIS*. Oxford University Press.
11. Jakeman, A. J., Beck, M. B. and McAleer, M. J. (1993), *Modeling Change in Environmental System*. John Wiley and Sons..
12. Kothari, C.R.(2007) *Research Methodology – Methods and Techniques*. 2nd revised ed. New Age International (P) Ltd. Publishers, New Delhi.
13. Marden, M. P. (2011) *Research Methods for Science* 1st edition. Paperback.
14. McKillup, S. (2006) *Statistics Explained. An Introductory Guide for Life Scientists*. Cambridge University Press, Cambridge, UK..
15. Moore, P. and Cobby, J. (1998). *Introductory Statistics for Environmentalists*. Prentice hall, Hamel Hempstead.
16. Rastogi, V.B. (2007). *Fundamentals of Biostatistics*. Ane Books India, New Delhi.
17. Schmoor, J.L.(1996). *Environmental Modelling. A Wiley-Interscience Publication*. John Wiley and Sons. Inc.
18. Sokal, R.R. and Rohlf F.J. (1995), *Biometry: The Principles and Practice of Statistics in Biological Research*. 3rd ed. W.H. Freeman and Co., USA..
19. Wainwright, J. and Mulligan, M. (2004), *Environmental Modeling*. : John Wiley and Sons.
20. Wrigglesworth, J. M. (1983) *Biochemical Research Techniques*. John Willy & Sons..Zar,
21. Jerrold H.(1998). *Biostatistical Analysis*. Prentice Hall, N.J.

M.Sc. Environmental Science: Semester-3
ENVIRONMENTAL MANAGEMENT AND PLANNING
Course Code-17EVS306DCEC
Exam Course Code-306

End Semester Exam : 80 marks

Internal Assessment : 20 marks

Total : 100 marks

Time : 3 hrs.

UNIT - I

Role of NGO's in public participation in environmental movements, Concepts of Environmental education and awareness Internationals environmental initiatives - the club of Rome report, Stockholm Declaration, environmental ethics.

UNIT - II

Vehicular pollution and urban air quality, Fly ash utilization, Eutrophication and restoration of Indian lakes, Wet land conservation, Water crisis-conservation of water.Narmada dam, Tehri dam, Almetti dam.

UNIT - III

Basic concepts of environmental planning, Environmental priorities in India, Land use planning: The land use plan (India). Soil surveys in relation to land use planning. Methods of site selection and evaluation, soil erosion, Formation and reclamation of Usar, alkaline and saline soil, waste lands and their reclamation, Desertification and its control.

UNIT - IV

Urban planning and rural planning for India. Sustainable development- principles and practices in relation to economics and ecology. Cost-benefit analysis- its relevance.Ramsar convention on wetlands, Vienna convention and Montreal Protocol, Kyoto protocol, Earth Summit, Agenda-21.

Note:

The question paper will have nine questions in all. Question No. 1 shall be compulsory and will contain eight short answer type questions (not exceeding 50 words each) covering entire syllabus. In addition, the question paper will have four units consisting of two questions from each unit of the syllabus. Candidate(s) are required to attempt one question from each unit. All questions carry equal marks.

Recommended Readings:

12. Saxena.K.D. ,*Environmental Planning, Policies & Programmes in India*
13. Anderson, David A. (2013) *Environmental economics and natural resource management*, 4th Edition Taylor and Francis.
14. Singh G. (2007) *Land resource management*, Oxford publishers.
15. Kathy Wilson Peacock. (2010) *Natural resources and sustainable developments*. Viva books.
16. Lynch, Daniel R. (2009) *Sustainable natural resource management for scientists and engineers*, Cambridge University Press.
17. Jaidev, Somesh (2010) *Natural resources in 21st century*. Oxford Publishers.
18. Kudrow, N. J (Ed) (2009) *Conservation of natural resources*, Nora Science, New York.
19. Kumar, H.D. (2001) *Forest resources: Conservation and management*. Affiliated EastWest Press.
20. Grigg, N. S. (2009) *Water resources management: Principles, regulations, and cases*, McGraw Hill Professional.
21. Beckman, D. W. (2013) *Marine environmental biology and conservation*. Jones and Barlett learning.
22. Primak R.B (2014) *Essentials of Conservation biology*, 6th edition, Sinauer Publishers.

ENVIRONMENTAL ETHICS AND PHILOSOPHY

Preamble: The main objective of this course will be to familiarise the students with the broad theories and parameters of environmental philosophy, including issues of animal rights, human rights and wilderness ideas. The effort will be to look at the philosophical basis of current conservation theories and competing views of environmentalism.

UNIT I

An Introduction to Environmental Ethics and Philosophy: Ethics in society; Environmental Consequences; Responsibility for Environmental Degradation

UNIT II

Theories of Environmental Ethics and Philosophy: Different types of schools of thought vis-à-vis nature and environmental management. Values in modernity, anti-modernity, eastern and western cultures, nature and religion etc. Eco Centric Theories of Nature: Deep ecology and animal rights theories, environmental rights, environmental racism.

UNIT III

Cross-cultural views on Nature: The relationship between humans, nature and adaptation. Theoretical frameworks of cultural and social ecology; debates on culture/nature divide. Environment and Business Ethics: Foundations of Environmental Ethics for Business, Corporate Environmental Ethics, Environmental Disclosure, Social and Ethical Issues for Sustainable Development, Business Ethics and Corporate Environmental Performance.

UNIT IV

Environmental Ethics and Issues of National and International Governance: changing nature of environmental ethics in relation to international and national paradigms of environmental governance. Resource consumption patterns and the need for equitable utilization; Equity disparity in the northern and southern countries; Urban – rural equity issues; The conservation ethics and traditional value system of India.

Suggested Readings:

- Aggarwal Anil & Narain Sunita, 1991, Global warming in an unequal world: A case of Environmental colonialism, Centre for Science & Environment.
- Cooper, D.E. & Palmer. J.A., (Ed.), 1992, The Environment in question: Ethics & Global Issues, London, Routledge.
- Des Jardius, J.R., 2001, Environmental Ethics: An invitation to Environmental philosophy (3rd Ed.), Wadsworth Publ., Belmont, California.
- Grim. John. A., 2001, Indigenous Traditions and Ecology (Ed.), Harvard University Press.
- Lesourd, J.B. and Schilizzi, S.G. M., 2001, The Environment in Corporate Management: New Directions and Economic Insights, Edward Elgar, UK.
- Vandever, D.C.P. and Vandever, D., 2002, The Environmental Ethics and policy book: Philosophy, Ecology, Economics (3rd Ed.), Wadsworth publishing, California.

Earth Processes

UNIT I

Evolution of various branches of Geology. Origin of the earth. Primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.

UNIT II

Magma generation and formation of igneous and metamorphic rocks. Concept of Minerals and Rocks. Weathering, erosion, transportation and deposition of earth's materials by running water, wind and glaciers. Formation of land forms and sedimentary rocks.

UNIT III

Plate tectonics- sea floor spreading, mountain building, evolution of continents and structural deformation.

UNIT IV

Thermal, magnetic and gravitational fields of the earth. Concepts of engineering and urban geology.