M. Sc. (Environmental Sciences)

Academic Session

2017-2018

Department of Humanities and Sciences
YMCA University of Science & Technology
Faridabad

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

VISION

"YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building."

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
FACULTY OF HUMANITIES AND SCIENCES

VISION

"A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry. "

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the road map becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

DEPARTMENT OF HUMANITIES AND SCIENCES
M. Sc. ENVIRONMENTAL SCIENCES

The two years M.Sc. course in Environmental Sciences is an interdisciplinary program with an emphasis on emerging areas of environment such as water, air, soil pollution and control, climate change, resource conservation, waste management and environmental impact assessment. The program is designed in such a way that the students get in-depth knowledge of scientific, technical, economic, legal as well as social aspects of environment. The subjects offered are innovative with major thrust being on research areas pertaining to environmental pollution control and treatment technologies. The course will not only equip the student with knowledge and expertise in the area of environmental sciences but will also create avenue for research and job opportunities in future.

PROGRAM EDUCATIONAL OBJECTIVES:

1. To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.
2. To sensitize students towards environmental concerns and issues, and make them able to apply their knowledge for sustainable development.
3. To provide intensive practical training on modern instrumentation and analytical techniques for environmental analyses.
4. To orient the students towards efficient environmental decision-making and management.
5. To develop understanding about the impacts of climate change and related mitigation strategies.
6. To prepare students for successful career in education, research, industries, consultancy, regulatory agencies, boards and departments, etc.

PROGRAM OUTCOMES:

After completion of the program, the students have:

1. Acquired fundamental knowledge and understanding of different aspects of environment.
2. Become aware of the local, regional and global environmental problems and acquired the knowledge and skills needed for the environmental management.
3. Developed environmental monitoring skills, including design and conduct of experiments and data analysis.

4. Obtained exposure to the environmental pollution control technologies.
5. Become aware of the environmental policies, legislation and regulations.
6. Acquired skills in the preparation, planning and implementation of environmental projects and obtaining firsthand experience of working in the environmental projects.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

SCHEME OF M. SC. ENVIRONMENTAL SCIENCES

(w.e.f. Academic session 2017-18)

SEMESTER I

S. No.	Subject Code	Title	L	T	P	Sessional Marks	Final Exam Marks	Total	Credits	Category code
1	EVS 101A	Ecology and Environment	4	0	0	25	75	100	4	DCC
2	EVS 102A	Environmental Chemistry	4	0	0	25	75	100	4	DCC
3	EVS 103A	Instrumental Techniques for Chemical Analysis	4	0	0	25	75	100	4	DCC
4	EVS 104A	Physical Environment	4	0	0	25	75	100	4	DCC
5	EVS 105A	Computer Applications	2	0	0	25	75	100	2	FC
6	EVS 106A	Seminar	0	0	2	50	-	50	1	DCC
7	EVS 107A	EVS – Lab I (Ecology)	0	0	6	30	70	100	3	DCC
8	EVS 108A	EVS – Lab II (Environmental Chemistry and Instrumental Analysis)	0	0	6	30	70	100	3	DCC
9	XXX	MOOC*								MOOC
		Total	**18**	**0**	**14**			**750**	**25**	

DCC – Discipline Core Course; FC – Foundation Course; MOOC – Massive Open Online Course
L – Lecture; T - Tutorial; P - Practical
*The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university. (Instructions to students overleaf)

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

SCHEME OF M. SC. ENVIRONMENTAL SCIENCES

SEMESTER II

S. No.	Subject Code	Title	L	T	P	Sessional Marks	Final Exam Marks	Total	Credits	Category code
1	EVS 201A	Water Pollution and Control Technologies	4	0	0	25	75	100	4	DCC
2	EVS 202A	Energy and Environment	4	0	0	25	75	100	4	DCC
3	EVS 203A	Air & Noise: Pollution and Abatement	4	0	0	25	75	100	4	DCC
4	EVS 204A	Soil Pollution and Management	4	0	0	25	75	100	4	DCC
5	EVS 205A	Environmental Statistical Data Analysis and Modelling	2	0	0	25	75	100	2	DCC
6	EVS 206A	Seminar	0	0	2	50	-	50	1	DCC
7	EVS 207A	EVS – Lab III (Water and Soil Analysis)	0	0	6	30	70	100	3	DCC
8	EVS 208 A	EVS – Lab IV (Air Pollution Sampling and Analysis)	0	0	6	30	70	100	3	DCC
9	XXX	Audit Course*	2	0	0	25	75	100	0	AUD
		Total	**20**	**0**	**14**			**850**	**25**	

DCC – Discipline Core Course; AUD-Audit Course
L – Lecture; T - Tutorial; P - Practical
*The students have to choose one Audit course from the list provided by the department/university. Only passing of the Audit course will be mandatory.
**Industrial Training (4-6 weeks) to be undertaken in industries, institutes, organizations, etc. or field work to be done at the end of IInd Semester and will be evaluated in IIIrd Semester.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES
SCHEME OF M. SC. ENVIRONMENTAL SCIENCES
SEMESTER III

S. No.	Subject Code	Title	L	T	P	Sessional Marks	Final Exam Marks	Total	Credits	Category code
1	EVS 301A	Industrial Water and Wastewater Treatment	4	0	0	25	75	100	4	DCC
2	EVS 302A	Solid and Hazardous Waste Management	4	0	0	25	75	100	4	DCC
3	EVS XXX	Elective I	4	0	0	25	75	100	4	DEC
4	EVS XXX	Elective II	4	0	0	25	75	100	4	DEC
5	EVS 306 A	Seminar	0	0	2	50	-	50	1	DCC
6	EVS 307A	EVS – Lab V (Industrial Water and Wastewater Analysis)	0	0	6	30	70	100	3	DCC
7	EVS 308 A	EVS – Lab VI (Waste Management)	0	0	6	30	70	100	3	DCC
8	EVS 309 A	*Industrial Visit/Field Work and Report Writing	0	0	2	50	-	50	1	DCC
9	XXX	Open Elective**	3	0	0	25	75	100	3	OEC
		Total	**19**	**0**	**16**			**800**	**27**	
***Discipline Elective Courses (Elective I and Elective II): Select any two courses from the following:										
3 & 4	EVS 303 A	Natural Resource Management	4	0	0	25	75	100	4	DEC
	EVS 304 A	Environmental Nanotechnology	4	0	0	25	75	100	4	DEC
	EVS 305 A	Natural Hazards and Disaster Management	4	0	0	25	75	100	4	DEC

DCC – Discipline Core Course; DEC – Discipline Elective Course; OEC – Open Elective Course
L – Lecture; T - Tutorial; P - Practical
*Industrial Training (4-6 weeks) to be undertaken in industries, institutes, organizations, etc. or Field work to be done at the end of IInd Semester.

**The students have to choose one Open elective course related to other branch of Science/Engg./other discipline required for enhancing professional performance as provided by the department/university.

***Discipline Elective Courses can be offered subject to availability of requisite resources/ faculty in the university/department.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

SCHEME OF M. SC. ENVIRONMENTAL SCIENCES
SEMESTER IV

S. No.	Subject Code	Title	L	T	P	Sessional Marks	Final Exam Marks	Total	Credits	Category code
1	EVS 401A	Environmental Impact Assessment and Auditing	4	0	0	25	75	100	4	DCC
2	EVS 402A	Ecotoxicology and Occupational Safety	4	0	0	25	75	100	4	DCC
3	EVS 403A	Environmental Microbiology and Biotechnology	4	0	0	25	75	100	4	DCC
4	EVS 404A	EVS – Lab VII (Pollution Management)	0	0	6	30	70	100	3	DCC
5	EVS 405A	Project Work	0	0	16	30	70	100	8	DCC
		Total	**12**	**0**	**22**			**500**	**23**	

DCC – Discipline Core Course
L – Lecture; T - Tutorial; P - Practical

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

The Audit course and Open elective courses offered by PG Department of Environmental Sciences:

Course	Subject	Subject Code
Audit Course	1. Environmental Awareness, Policies and Laws	AES-201A
Open Elective Course	1. Waste Management in daily Life	OES-301A
	2. Environmental Conservation	OES-302A

1. The students have to choose one Audit course (0 credit) from the list provided by the department/university. Only passing of the Audit course will be mandatory.

2. The students have to choose one Open elective course (03 credits) related to other branch of Science/Engg./other discipline required for enhancing professional performance as provided by the department/university.

Grading Scheme

*Percentage	Grade	Grade Points	Category
95-100	O	10	Outstanding
85-95	A+	9	Excellent
75-85	A	8	Very Good
65-75	B+	7	Good
55-65	B	6	Above Average
45-55	C	5	Average
40-45	P	4	Pass
<40	F	0	Fail
.....	Ab	0	Absent

*Lower limit included upper limit excluded.

The multiplication factor for CGPA is 10.

1. Automatic Rounding.
2. Average difference between actual percentage and CGPA percentage ± 2.5%.
   Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 101A

SUBJECT NAME: ECOLOGY AND ENVIRONMENT

NO. OF CREDITS: 4

M SC SEMESTER I			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The students are expected to understand basic knowledge of ecological principles and ecosystems. They will know about different levels of the living world starting with the biology of organisms, then populations and finally the communities. The students will work on case studies related to each level of organization. The course will also provide the understanding of the principles of biodiversity in an ecological and social context.

UNIT-I: INTRODUCTION TO ECOLOGY

Introduction: Aims and scope of ecology, biological levels of organization-genes to biosphere; history, origin and evolution of life, Habitat and niche, adaptation, ecosystem, biotic and abiotic factors, food chain, food web, trophic level, Biogeography – classification and zones, Theory of Island Biogeography.

UNIT-II: ECOSYSTEM DYNAMICS

Concept and components of ecosystem, ecological pyramids, energy flows in different ecosystems, ecosystem productivity, methods of measuring primary productivity, biogeochemical cycles- cycling of water and nutrients, Ecosystem stability and regulation, Gaia hypothesis. Types and characteristics of ecosystem- terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, natural and man-made ecosystems.

UNIT-III: POPULATION AND COMMUNITY ECOLOGY

Population characteristics, population interaction, prey-predator relations, competition, exploitation, mutualism, parasitism, allelopathy, Population growth and regulation. Community structure and organization, Concept of metapopulation, demes and dispersal, niche- concept and types, keystone species, Flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators; ecological succession – types and mechanism.

UNIT-IV: BIODIVERSITY

Definition, levels of biodiversity, measurements of biodiversity, values of biodiversity. Hot spots of biodiversity, Biodiversity hotspots of India, threats to biodiversity. Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India. Causes of species extinction. Endangered and threatened species, IUCN Categories of threatened

species, Red data book, List of threatened flora and fauna in India. Biodiversity conservation; Ecotourism, role of inter-governmental, government and non-government organizations, legal initiatives for wildlife and forest conservation, wetland conservation, ecosystem management at national and international level; Convention on Biodiversity.

COURSE OUTCOMES:

Upon completion of this course, a fully-engaged student will be able to:

- The students will be able to demonstrate knowledge of the important ecological principles operating at different levels of organization.
- The students will be able to understand structure and function of ecosystems and concepts of energy flow, biogeochemical cycles, etc.
- The students will be able to describe about population and community ecology.
- The students will be to interpret ecological and social phenomena from a biodiversity view point and understand and frame conservation measures on new or endangered species in a given habitat.

REFERENCES:

1. Brewer, R. The Science of Ecology, Sanders College Publishing Co., Tokyo, 1994.
2. Odum, E.P. Basic Ecology, W.B. Saunders, Philadelphia, 1983.
3. Fatik B. Mandal and Nepal C. Nandi. Biodiversity: Concepts, Conservation and Biofuture, Asian Books, 2013.
4. Jorgensen, Sven Erik. Encylopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands, 2008.
5. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management. APH, New Delhi, 2009.
6. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi, 2009.
7. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis, 2009.
8. Odum, E.P., Barrick, M. and Barret, G.W. Fundamentals of Ecology (5th Ed).Thomson Brooks/Cole Publisher, California, 2005.
9. Rana, S.V.S. Essentials of Ecology and Environmental science (5th Ed), PHI Learning Pvt. Ltd, 2013.
10. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi, 2009.
11. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.
12. Smith, T.M and Smith, R.L. Elements of Ecology (8th Ed), Benjamin Cummings, 2012.
13. Vandermeer, John H., Riddle, B.R. and Brown, J.H. Population Ecology : First principle (2nd Ed). Princeton University Press, 2013.
14. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 102A

SUBJECT NAME: ENVIRONMENTAL CHEMISTRY

NO. OF CREDITS: 4

M SC SEMESTER I			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The objective of the course is to provide detailed understating of various aspects of air, water and soil chemistry. The course has been designed to acquaint students with chemical constituents present in the environment, interactions between them and manner in which changes are brought about due to pollution.

UNIT-I: CHEMISTRY FOR ENVIRONMENT

Fundamental of environmental chemistry: Mole Concept, Solution chemistry, solubility product, Solubility of gases, Phase change, thermodynamics, Electrochemistry and redox reactions, Gibbs' free energy; Chemical potential; chemical kinetics and chemical equilibrium. Sources of natural and artificial radiations. Applications and handling of isotopes and other radionuclides in environment.

UNIT-II: AIR & WATER CHEMISTRY

Atmospheric Chemistry: Chemical composition of atmosphere- atmospheric water and CO_2; particles, ions and radicals in atmosphere, formation of particulate matter, Photo-chemical and chemical reactions in the atmosphere, thermal inversion, photochemical smog, acid rain, chemistry of ozone layer depletion; greenhouse gases and global warming.

Aquatic chemistry: Structure and properties of water, Water quality parameters, Physico-chemical concepts of color, odour, turbidity, pH, conductivity, DO, COD, BOD, alkalinity, carbonate system in water, redox reactions.

UNIT-III: SOIL AND GEOCHEMISTRY

Soil Chemistry: Physio-chemical composition of soil, humus, Inorganic and organic components of soil, nutrients (NPK) in soil, significance of C:N ratio, Cation exchange capacity (CEC), Reactions in soil solution.

Environmental geochemistry: Concept of major, trace and REE. Classification of trace elements, Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, O_3, PAN, MIC and other carcinogens.

UNIT-IV: GREEN CHEMISTRY

Green chemistry and green technology: New trends in green chemistry, Basic principles, Atom economy concept and its environmental importance, Green reagents, Green solvents, Green technology: Microwave heating & pollution, Ultrasound technique, Industrial Ecology.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Develop concepts of basic chemistry associated with the occurrence of environmental pollutants.
- Understand various aspects of air and water chemistry so as to acquaint students with chemical constituents present in air and water, interactions among them and manner in which changes are brought about due to pollution.
- Describe the basic aspects of soil chemistry and environmental toxicants.
- Understand the latest technologies including green chemistry to reduce the impacts of pollutants in the environment.

REFERENCES:

1. Baird, C. and Cann, M. (2008). *Environmental Chemistry,* W.H. Freeman, USA.
2. Manahan, S. E. (2008). *Fundamentals of Environmental Chemistry*, 3rd Edition, CRC Press, USA.
3. Connell D. W. (2005). *Basic concepts of Environmental Chemistry* 2nd Edition, CRC Press, USA.
4. Girard J. (2010). *Principles of Environmental Chemistry* 2nd Edition, James & Barlett Publishers, USA.
5. Harrison R M (2007). *Principles of Environmental Chemistry*, RSC Publishing, UK.
6. Hillel, D. (2007). *Soil in the Environment: Crucible of Terrestrial Life,* 1st edition, Academic Press, USA.
7. Lancaster M.(2002). *Green Chemistry: An Introductory Text*, RSC Publishing, UK.
8. Manahan, S. E. (2006). *Green chemistry and the ten commandments of sustainability,* 2nd Edition, Chem Char Inc. Publishers, USA.
9. Manahan, S. E. (2010). *Water chemistry: green science and technology of nature's most renewable resource,* CRC Press, USA.
10. Clark J. H. and Macquarrie, D. J. (2002). *Handbook of Green Chemistry and Technology*, Wiley-Blackwell, UK.
11. Pierzynski, G.M., Sims, J.T. and Vance, G.F. (2000). *Soils and Environmental Quality*. Second Edition. CRC press, New York.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 103A

SUBJECT NAME: INSTRUMENTAL TECHNIQUES FOR CHEMICAL ANALYSIS

NO. OF CREDITS: 4

M SC SEMESTER I			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The objective of the course is to develop sampling and analytical skills of the students which are required in environmental monitoring. The students will be able to perform quantitative analysis of various physical, chemical and biological pollutants in environment with reference to air, water and soil. The students will acquire knowledge about various standard protocols used in environmental monitoring. The course will also help the students to learn the theory and concepts and develop their practical skills to use the contemporary tools and techniques required for environmental impact assessment.

UNIT-I: QUANTITATIVE ANALYSIS

Acid-base, complexometric, precipitation and redox titrimetry. Gravimetric analysis – total solids, suspended solids and volatile solids.

UNIT-II: SPECTROMETRIC AND THERMOGRAVIMETRIC METHODS

Spectrophotometry and Colorimetry, UV- Visible spectrophotometer, fluorescence, Flame photometry, Atomic absorption and atomic emission spectrophotometry, molecular structure determination using X- ray, fluorescence and X-ray diffraction, different types of mass spectrometry and surface plasma resonance.

Thermogravimetric Analysis, Differential Scanning Calorimetry.

UNIT-III: INSTRUMENTS

pH meter, Conductivity meter, TDS meter, DO meter, Salinity meter, Ion Selective Coulometry, Anode and cathode stripping voltammetry, dropping mercury electrode (DME), merits and demerits of DME.

UNIT-IV: SEPARATION/ CHROMATOGRAPHIC TECHNIQUES

Partition coefficient, chromatography, general chromatography, chromatographic methods: Paper, Thin Layer chromatography, Column, High Performance Thin Layer Chromatography (HPTLC), Gas Chromatography (GSC and GLC), GC-MS, High Pressure Liquid Chromatography, Ion Exchange chromatography, Ion/Size Exclusion Chromatography and Electrophoresis.

COURSE OUTCOMES:

On completion of the course, the students will be:

- Able to perform quantitative analysis of various physical, chemical and biological pollutants in environment with reference to air, water and soil.
- Trained in analytical and conceptual skills required for environmental chemistry research.
- Able to design and carry out a method of environmental chemical analysis, including instrumental analysis.
- The course will also help the students to learn the theory and concepts and develop their practical skills to use the contemporary tools and techniques required for environmental impact assessment.

REFERENCES:

1. Skoog D. A., Holler F.L. and Crouch, S. R.(2007); *Principles of instrumental analysis*, Thomson Brooks/Cole Publishers, USA
2. Svehla G. (1996); *Vogel's qualitative inorganic analysis, 7th Edition,* Prentice Hall, USA
3. Wiersma G.(2004); *Environmental monitoring,* CRC Press, UK.
4. Eaton, A. D., Clesceri, L.S., Rice, E.W. and Greenberg, A.E. (2005); *Standard methods for examination of water and wastewater 21st Edition.* American Public Health Association, American Water Worker Association, Water Environment Federation, USA.
5. Ewing, G. W. (1985); *Instrumental methods of chemical analysis, 5th edition,* McGraw Hill Publications, USA
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7. Shukla, S. K. and Srivastava, P. R. (1992); *Methodology for environmental monitoring and assessment,* Commonwealth Publishers, New Delhi.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 104A

SUBJECT NAME: PHYSICAL ENVIRONMENT

NO. OF CREDITS: 4

M SC SEMESTER I			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The objective of the course is to provide knowledge and understanding of different aspects of atmosphere, hydrosphere and lithosphere. The students will become aware of the interrelationships between biosphere and environmental components.This would also serve as a base for different applied aspects of environmental science e.g. GIS & remote sensing, disaster management and environmental impact assessment and management.

UNIT-I: EARTH PROCESSES

Structure and Composition of the Earth; Plate tectonics; Formation of oceans and landmasses; Mountain Building; Mass Movements; Volcanicity; Seismicity; Formation of lakes, rivers and streams; Wind; Glacial processes; Weathering and Erosion; Mass movement; Geological Time Scale.

UNIT-II: METEOROLOGY

Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiation Budget of Earth; Application of meteorological principles to transport and diffusion of pollutants, Topographic effects, cloud classification and formation.

UNIT-III: CLIMATOLOGY

The boundary layer, Radiations: Radiation laws, short wave and long wave radiations, Albedo, Emissivity, Inversion, Local microclimate, Greenhouse effect, Radiation balance, Precipitation, Atmospheric movements, Distribution of radiation, Rotation of earth- Coriolis acceleration, angular momentum, General meridional circulations, Hadley cells, Middle latitudes, Circulation of water and energy in atmosphere, Weather and Climate in India, El Nino, La Nina, seasons and monsoons, Climatic classification schemes, Biogeographical regions of the world, Climate change - Emissions and Global warming, impact on sea level in South Asian region, Environmental disruptions and their implications .

UNIT-IV: OCEANOGRAPHY

Sea water properties, Chemistry of seawater, Wind driven circulations in upper oceans, Waves, Tides and Currents, Upwelling and El Nino, Deep Ocean Circulations, Marine Resources, Marine flora and fauna- Benthic and Pelagic Communities, Marine Pollution, Global Warming and Oceans - Greenhouse effect, Ocean warming, Sea level rise, Acidification, Carbon sequestration.

COURSE OUTCOMES:

On completion of the course, the students will be:

- Aware of the basic phenomenon's of earth sciences.
- Able to apply the effects of meteorological parameters in the dispersion of air pollutants.
- Acquainted with different concepts of meteorology, climatology and oceanography.

REFERENCES:

1. Bell F. G., (1998). *Environmental Geology: Principles and Practice*. Blackwell Science Publisher, USA.
2. Critchfield H. J. (2009). *General Climatology*, PHI Learning, New Delhi.
3. Kale, V. S. and Gupta, A. (2001). *Introduction to Geomorphology*. Orient Longman, Bangalore.
4. Singh, S. (2011), *Physical Geography*, Prayag Pustak Bhavan, Allahabad.
5. Strahler, A.N. and Strahler (1996). *An Introduction to Physical Geography*. John Wiley & Sons, UK.
6. D.S. Lal (2011). Climatology, Sharda Pustak.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 105A

SUBJECT NAME: COMPUTER APPLICATIONS

NO. OF CREDITS: 2

M SC SEMESTER I			SESSIONAL : 25
L	T	P	FINAL EXAM: 75
2	0	0	TOTAL : 100

COURSE OBJECTIVES:

The course has been designed with the objective to provide the basic knowledge about the computer and its applications. The course will help the students in performing various calculations in research to present the results in a more meaningful manner.

UNIT-I:

Fundamentals of Computers, Hardware Components, Introduction to computer network and World Wide Web.

UNIT-II:

Sharing Data over Network, Computer Configuration, Memory Hierarchy, Software Structure, Introduction to MS Word, Paint and Notepad.

UNIT-III:

Introduction to Word Processing and Microsoft Office, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management.

UNIT-IV:

Spreadsheet applications, Presentation applications, Internet browsers and Image processing applications.

COURSE OUTCOMES:

After completing this course, the students will be able to:

- Acquire the basic knowledge of computer and its applications.
- Compute the data in a more meaningful manner.

REFERENCES:

1. Gookin, D. (2007). MS Word for Dummies.Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. Wiley.
3. Sinha, P.K., Computer Fundamentals, BPB Publications.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 106A

SUBJECT NAME: SEMINAR

NO. OF CREDITS: 2

M SC SEMESTER I			SESSIONAL : 50
L	T	P	FINAL EXAM: -
0	0	2	TOTAL : 50

COURSE OBJECTIVES:

The objective of the course is to provide the students exposure to the recent developments and to improve the student's presentation skills.

COURSE DESCRIPTION:

Every student shall have to deliver a Seminar on a recent topic related to Environmental Sciences. Seminar will be of 1 hr. duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/ Faculty members well in advance so that the same may be displayed on the notice board.

The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

COURSE OUTCOME:

The students will get better employability and communication skills.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 107A

SUBJECT NAME: EVS - LAB I (ECOLOGY)

NO. OF CREDITS: 3

M SC SEMESTER I			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

COURSE OBJECTIVES:

The students will be trained in designing the scientific methods/experiments to study various ecological parameters and biodiversity in laboratory/field conditions.

List of Experiments

1. To determine minimum quadrat size for studying vegetation in a grassland.
2. To study the community by quadrat method by determining frequency, density and abundance of different plant species present in a grassland.
3. To determine basal area and dominance of species.
4. To calculate Importance value index (IVI) of species.
5. To calculate index of diversity, richness, evenness and dominance of species.
6. To study ecology of some more exotic invasive weeds.
7. To study and enlist various biotic and abiotic components of pond and forest ecosystem.
8. To estimate chlorophyll content of plant leaves.
9. To estimate carbohydrate content in given plant sample.
10. To estimate protein content in the given sample.

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.

COURSE OUTCOME:

The students will be able to perform different experiments to analyze various ecological parameters in the field.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 108A

SUBJECT NAME: EVS - LAB II (ENVIRONMENTAL CHEMISTRY AND INSTRUMENTAL ANALYSIS)

NO. OF CREDITS: 3

M SC SEMESTER I			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

COURSE OBJECTIVES:

The course has been designed to train the students in the laboratory for quantitative analysis of various physical, chemical and biological pollutants in environment and to provide firsthand experience on various instruments.

List of Experiments

1. Determination of pH value of a given water sample using pH meter.
2. Determination of Electrical conductivity/TDS of a given water sample using conductivity meter.
3. Determination of Acidity of a given water sample.
4. Determination of alkalinity of a given water sample by titration method. (Neutralization titration)
5. Determination of temporary and permanent hardness of a given water sample. (Complexometric titration)
6. Determination of total, calcium and magnesium hardness of a given water sample.
7. Determination of chloride of a given water sample. (Precipitation titration)
8. Determination of TSS and TDS of a given water sample by gravimetric method.
9. To calculate the lambda max of the given compound by using UV-Vis spectrophotometer.
10. Determination of hexavalent chromium in given water sample by UV-Vis spectrophotometer.
11. Determination of turbidity of given water sample using Nephelometer.

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.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Analyze and quantify various environmental parameters/pollutants present in environment.
- Perform environmental quality measurements.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 201A

SUBJECT NAME: WATER POLLUTION AND CONTROL TECHNOLOGIES

NO. OF CREDITS: 4

M SC SEMESTER II			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The objective of the course is to develop understanding of water quality criteria, standards, impacts of water pollutants and treatment methods. It focuses on causes and effects of water pollution and water quality degradation from different sources. The students will be educated on the principles, designs and functions of the unit processes in water or wastewater treatment and basic equipments that each process uses.

UNIT-I: DRINKING WATER CHARACTERISTICS AND PURIFICATION TECHNIQUES

Water Sources – Availability & quality of Surface water and Ground water, Water Requirements for Domestic Consumption (Population forecasting), Water Treatment process – Principal, process design and applications (Aeration, flocculation, Sedimentation, Filtration, Disinfections (Chlorination, UV, Ozonization), water softening, Drinking water standards (physical, chemical & bacteriological).

UNIT-II: WATER POLLUTION

Sources, types, Causes and consequences of water pollution, water pollutants (organic, inorganic, biological and radioactive pollutants), Marine pollution, Thermal pollution, Oil pollution, Classification of wastewater, Bioindicators.

Characteristics of water and wastewater, Sampling of water and wastewater, collection and storage, physical chemical and biological analysis of water and wastewater.

UNIT-III: WASTEWATER TREATMENT

Wastewater generation, objectives of waste water treatment, Primary, secondary, Tertiary treatment: sedimentation, coagulation and flocculation, filtration, disinfection, activated sludge process, trickling filters, and anaerobic (UASB) processes, Suspended, attached and hybrid reactors, operational parameters. Sludge treatment – Preliminary operation, Thickening, Conditioning, Dewatering, Filtration, Digestion and Drying of sludge, Sludge disposal. An introduction to common ETPs and STPs.

Wastewater treatment for small communities – Oxidation ditch, SBR, Process design and operation of mechanically aerated lagoon and Waste stabilization pond system.

UNIT-IV: WATER RESOURCE MANAGEMENT

Watershed management, Eutrophication, Recovery of eutrophicated lakes, rehabilitation of polluted rivers-Ganga Action Plan, Yamuna Action Plan and new Plans introduced by Govt. of India, Rain water harvesting.

COURSE OUTCOMES:

After completion of this course, the students will be able to:

- Acquire the knowledge of basic rationale of water quality management.
- Suggest the suitable technologies for the treatment of drinking water and wastewater.
- Design the water and wastewater treatment plant with various capacities.
- Know the various methods for water resource management.

REFERENCES:

1. Wastewater Engineering: Treatment, disposal, Reuse – Metcalf & Eddy Inc.4th ed. TMGHl, New Delhi, 2003.
2. Environmental Engineering- Peavy, HS, Donald RR & G. Tchobanoglous, MGH Int. Ed. New York, 1985.
3. Edzwald, James K. (ed.) Water quality & treatment: A handbook on drinking water
4. Ujang, Zaini (Ed.) Municipal wastewater management in developing countries: Principles and Engineering.
5. Natural Resources conservation-Oliver S Owen & Chiras
6. Natural Resource Conservation-Owen & Chiras
7. Living in the Environment –T.J.Miller

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 202A

SUBJECT NAME: ENERGY AND ENVIRONMENT

NO. OF CREDITS: 4

M SC SEMESTER II			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The course will provide the students a fair understanding of various energy resources, energy situation, energy production, utilization and the impacts on environment, environment protection, techniques/devices to protect the environment due to pollution arising out of use of various energy resources, global warming, climate change and mitigation measures. Further, the student will have a broad view of energy and environment policy of India. They will get the knowledge on principles, technologies and economics of bio-energy for energy and environmental conservation.

UNIT-I: ENERGY RESOURCES

Introduction to energy sources, Energy scenario in world and India, Potential and perspectives of various energy sources in India, classification of energy resources-conventional and non conventional, renewable and non- renewable, environmental implications of energy resources, National energy plan, energy conservation and audit.

UNIT-II: CONVENTIONAL ENERGY

Fossil fuels (Coal, petroleum, LPG and natural gas) – origin, composition and physico-chemical characteristics and energy content, sources properties and production process; Pollution from use of energy: combustion products of fossil fuels, methods of controls of major pollutants - SOx [Flue gas desulphurization (FGD) systems], removal of NOx from flue gas (De-NOx system). Green Belt development and its importance.

Nuclear energy– fission and fusion, technologies – nuclear enrichment, nuclear reactors, nuclear waste disposal, policies and regulations

UNIT-III: NON-CONVENTIONAL ENERGY

Prospects of renewable non-conventional energy, Types - solar energy, wind energy, hydel, tidal and geothermal energy, OTEC: introduction, principle, generation. Solar collectors, applications of solar energy: Solar water heating, solar heating and cooling of buildings, solar photo-voltaics, solar distillation, solar cooking and solar ponds. Basic components of wind energy conversion system, types and applications of wind energy.

UNIT-IV: WASTE TO ENERGY AND ENERGY CONSERVATION

Bioenergy - Biomass energy as an energy source, characteristics of biomass, Energy plantations, Biomass conversion technologies. Types of biofuels - Biodiesel, bioethanol, biogas, biohydrogen - importance, production, technologies and applications.

Waste to resource recovery and recycling for energy, conversion technologies. Feed stocks, factors affecting biogas generation, Biogas plants: Classification of biogas plants, advantages and disadvantages of biogas plants, community biogas plants. Microbial fuel cell – principle, types and challenges. Energy conservation – principles and approach, energy conservation in buildings, green buildings, solar passive architecture, eco-housing, energy audit, national and international norms**.**

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Acquire scientific and technical understanding on the energy and associated environmental issues.
- Get acquainted with the environmental impacts of energy technologies.
- Understand the necessity to go for alternative energy and potential for bioenergy and methods to explore the energy in biological mode.

REFERENCES:

1. Carla W. Montgomery, Environmental Geology, 5th ed., Mc Graw Hill Higher Education (2000).
2. G.D. Rai, Non Conventional Energy Sources, 4th ed., Khanna Publication (1996).
3. S.A. Abbasi, Renewable Energy Sources and Their Environmental Impact, 1st ed. Ashok K. Ghosh, Prentice Hall of India (2001).
4. H.P. Garg and J.Prakash, Solar Energy Fundamentals and Applications, Tata Mc Graw Hill (1992).
5. S.P. Sukhantine, Solar Energy: Principles of Thermal Collection and Storage, 2nd ed., Tata Mc Graw Hill (1992).
6. S.Rao and B. Prulaker, Energy Technology, 1st ed., Khanna Publications (1996).
7. Lal, Banwari and Sarma, P.M., Wealth from waste: Trends and technologies, TERI (2011).
8. MNRE, Griha manual volume - 3: Technical manual for trainers on building and system design optimization renewable energy application, Ministry of new and renewable energy, 2011.
9. Pagliaro, Mario and Konstandopoulos, A.G. Solar hydrogen : Fuel of the future, Royal Society of Chemistry, 2012
10. Prasad, S and Dhanya M.S Biofuels, Narendra Publishing house, New Delhi, 2013
11. Rani Devi, Mohd. Kashif Kidwai, Pawan Kumar Rose and Alok Kumar Saran , Energy-water-waste nexus : For environmental management, Narosa Publishing House, 2012
12. Rathore, N.S. Renewable energy sources for sustainable development
13. Sawhney, G.S. Non - coventional energy resources, PHI Learning Private Limited, 2012.
14. Sukhatme, S.P. *Solar Energy – Principles of Thermal Collection and Storage.*Tata McGraw Hill. 2000.
15. Tiwari, G.N. Solar energy: Fundamentals, design,modeling and applications, Narosa Publishers, 2002.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 203A

SUBJECT NAME: AIR & NOISE: POLLUTION AND ABATEMENT

NO. OF CREDITS: 4

M SC SEMESTER II			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

This course aims to provide the students with a variety of perspectives on the air pollution issues. The students will get an insight into sources of air pollution, their effects and dispersion in the atmosphere. The students will be acquainted with air pollution control devices, their constructional features and working principles. Further, the students will be familiarized with the basic concepts of noise pollution and its control.

UNIT-I: AIR POLLUTION AND CLIMATE CHANGE

Air pollution – world and Indian scenario, Sources and classification of air pollutants, Air pollutants, effects and consequences, Atmospheric Aerosols. The air (Prevention and Control of Pollution) Act – 1981 and its Amendments, Geneva Convention on long range transport of atmospheric pollutants.

Climatic Change, Tools to study climate change, mitigation strategies for global warming; biological and geological carbon sequestration, Kyoto protocol, carbon trading, Carbon footprints and a case study of coal based Thermal Power Plant, Global environmental change programmes, IPCC, COP, Indian initiatives for mitigating climate change.

UNIT-II: AIR MONITORING

Ambient air sampling using impactor, Cyclone, dichotomous and impingement devices, filter media selection. Adsorption and adsorption based sampling, Indoor environment monitoring.

Industrial Monitoring: Flow velocity and temperature monitoring, isokinetic sampling and compositional analysis, Flue gas analyzer principles for monitoring COx, NOx, SOx, hydrocarbon.

Air dispersion and Modelling**:** Plume behaviour and principles of air pollutants dispersion (Gaussian dispersion model) Plume rise estimation, Effluent dispersion theories and Atmospheric and Indoor chemical modelling.

UNIT-III: AIR POLLUTION CONTROL TECHNOLOGIES

Particulates - filters, gravitational, centrifugal-multiple type cyclones, Scrubbers and electrostatic precipitators, Adsorbents, PSA, adsorption cycle, rotary bed/fluidized bed, Condensation -

contact condensers, shell and tube condenser, flaring. Gaseous Pollutants - absorption: Packed and plate columns. Low NOx burner, Wellman Lord Process, Fuel desulphurization and denitrogenation.

Vehicular Pollution Control: Combustion Cycle, Fuel/air ratio and Catalytic convertor; selective catalytic and selective non-catalytic reduction.

UNIT-IV: NOISE POLLUTION

Definition, sources, properties of sound waves, Sound pressure, intensity, decibel, measurement and analysis of sound, Noise Indices, Sound absorption, Meteorological effects on Noise propagation, Effects and impacts on human, Noise exposure level and standards, Control of Noise pollution, Preventive measures and abatement measures.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Understand the type and nature of air pollutants, the behaviour of plumes and relevant meteorological determinants influencing the dispersion of air pollutants.
- Discuss the air pollution emission standards.
- Suggest suitable air pollution prevention equipments and techniques for various gaseous and particulate pollutants to industries.
- Understand the technical aspects of regulating and controlling air and noise pollution.

REFERENCES:

1. Jeremy, C., Tiwary, A. and Colls, J. (2009). Air pollution: measurement, modeling and mitigation, 3rd Edition, Crc Press, USA.
2. Clarke A. G. (1997). Industrial air pollution monitoring: gaseous and particulate emissions, Springer, USA.
3. Kenneth Jr., W., Davis, W. T., Warner C. F. (1998). Air pollution and its origin and control,3rd edition, Prentice Hall, USA.
4. Cheremisinoff N. P. (2002). Handbook of air pollution prevention and control, Butterworth-heinemann Publishers, UK.
5. Rao, C.S. (2006). Environmental pollution control engineering, New Age International Publishers, New Delhi.
6. Vallero, D. A. (2007). Fundamentals of air pollution 4th edition, Academic Press, USA.
7. Wang, Lawrence K. Wang, Lawrence K. Pereira Norman C. (2004). Advanced air and noise pollution control.
8. Industrial Noise Control- Bell & Bell

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 204A

SUBJECT NAME: SOIL POLLUTION AND MANAGEMENT

NO. OF CREDITS: 4

M SC SEMESTER II			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The course has been designed to improve the understanding of the students about soil pollution and its control. The course will also provide the knowledge about the sources of soil pollution and their impacts on environment and health. They will develop the skills to apply remediation techniques to combat soil pollution. In addition, the students will become aware of various methods for soil management as well as eco-agriculture.

UNIT-I: SOIL FORMATION

Definition, rocks, minerals, soil forming factors, soil weathering- types and processes, soil formation, soil horizon, soil profiles, composition of soil, soil biota and their function in soil, humus, Soil microbes in nutrient cycling, Soil types in India. Physico-chemical and biological properties of soil, sampling and analysis of soil quality.

UNIT-II: SOIL POLLUTION AND SOIL EROSION

Definition, sources- point and non-point, routes. Soil pollutants – Types, pesticides – classification, formulation, residual toxicity, synthetic fertilizers, heavy metals, Industrial waste effluents and interaction with soil components. Effects and impacts of soil pollution, biomagnification.

Salt affected soil – Saline soils, Sodic soil, Usar, Kallar, Types of erosion – water and wind erosion, causes, soil loss equation. Land degradation – causes and impacts, types of waste lands in India, desertification and its Control.

UNIT-III: SOIL MANAGEMENT

Methodologies for soil conservation, conservation of arable land, techniques of reclamation and restoration of soil, wasteland reclamation, soil salinity management, remedial measures for soil pollution, Principles of weed management, Legal measures for land conservation at national and international level.

UNIT-IV: ECO-AGRICULTURE

Natural plant products as bioherbicides, Organic farming, Eco-farming, Biofertilizers. Terrestrial Phytotechnology: Phytoremediation, Phytovolatilization, Phytodegradation, Phytostabilization - Aquatic Phytosystems: Blastofiltration, Rhizoremediation, Constructed wetlands; fly ash treatment.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Understand various means of soil contamination, their possible effects and control.
- Discuss the method for reducing soil erosion and soil management.
- Understand the concept of eco-agriculture.

REFERENCES:

1. Botkin, Daniel B. and Keller, Edward A. *Environmental Science: Earth as a Living Planet*. 6th ed. John Wiley & Sons, USA. 2007.
2. Cutler, S.L, *Environment Risks and Hazard*. Prentice Hall of India, Delhi. 1999.
3. De, A.K., *Environmental Chemistry*. New Age International (P) Ltd. Publishers, New Delhi. 2000.
4. Hillel, D., *Introduction to Soil Physics*, Academic Press, New York. 1982.
5. Kapoor, B.S. *Environmental Sanitation.* S. Chand & Sons, New Delhi. . 2000.
6. Raven, Peter H., Berg, Linda R. and Hassenzahl, David M. *Environment.* 6th ed. John Wiley & Sons., USA. 2008.
7. Sanai, V.S. *Fundamentals of Soil.* Kalayani Publishers, New Delhi. 1990.
8. Singh, H.P., Batish, D.R. and Kohli, R.K. *Handbook of Sustainable Weed Management*. Haworth Press, Inc., USA. 2006.
9. Singh, R.A. *Soil Physical Analysis*, Kalayani Publishers, New Delhi. 1997.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 205A

SUBJECT NAME: ENVIRONMENTAL STATISTICAL DATA ANALYSIS AND MODELLING

NO. OF CREDITS: 2

M SC SEMESTER II			SESSIONAL : 25
L	T	P	FINAL EXAM: 75
2	0	0	TOTAL : 100

COURSE OBJECTIVES:

The course is designed to acquaint the students with statistical tools and techniques available for analysis of environmental data. The course is about how to extract information from data and how informative data are generated in the first place. An effort has been made through this course to provide some useful tools to develop the necessary science, craft and art to analyze and represent data in a scientifically presentable form and to design systems for environmental protection. This course also provides basic understanding of Environmental Systems Analysis and exposure to some of the commonly used ecological and pollution models.

UNIT-I:

Basic elements and tools of statistical analysis, mean, median, mode, range & standard deviation, confidence interval of the mean, sampling, probability, measurement and distribution of attributes, Distribution – Normal, t and chi square, Poisson and Binomial.

UNIT-II:

Types of errors, accuracy and precision, rounding off, significant figures, normal distribution of errors, standard error of a mean, test of significance, t-test, F-test, rejection of data, Q-test, bivariate data, Quality control charts.

UNIT-III:

Relationship between variables, correlation & regression, principle of least squares, skewness, ANOVA one way and two way classification.

UNIT-IV:

Introduction to environmental system analysis, Linear Simple and multiple Regression models, Models of Population growth and interactions - Lotka-Voltra Model and Leslie's matrix model, Point Source Stream Pollution model, Box model and Gaussian Plume Model and advanced models.

COURSE OUTCOMES:

After completing this course, the students will:

- Obtain knowledge of probability and distributions and become capable of mathematical expectations.
- Acquire the skills of regression and correlation analysis, and development of statistical models and their use.
- Become capable of design of experiments for R&D work and testing of the related hypotheses.
- Have understanding of the environmental systems and their analysis and become acquainted with the widely used ecological and environmental models.

REFERENCES:

1. C.S. Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Age International Ltd., (1995).
2. Dynamics of Environmental Bioprocesses-Modelling and simulation-Snape and Dunn.
3. Environmental Modeling– Jorgensen
4. Murray R. Spiegel and Larry Stephens (1999). Schaum Outline of Statistics. McGraw-Hill Education (ISE Editions); International 3 Revised ed of edition (1 July 1999).
5. Meyer. P.L. (1975). Introductory Probability and Statistical Applications Oxford & IBH Pub, 1975.
6. Hogg, R.V. and Raise, A.T. (1978): Introduction to mathematical statistics, Macmillan Pub. Co. Inc.
7. Croxton, F.E. and Cowden, D.J. (1975): Applied General Statistics.
8. Hoel, P.G. (1997). Introduction to Mathematical Statistics.
9. Fundamental of Mathematical Statistics-S C Gupta and V K Kapoor, S. Chand &Sons Publisher.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 206A

SUBJECT NAME: SEMINAR

NO. OF CREDITS: 2

M SC SEMESTER II			SESSIONAL : 50
L	T	P	FINAL EXAM: -
0	0	2	TOTAL : 50

COURSE OBJECTIVES:

The objective of the course is to provide the students exposure to the recent developments and to improve the student's presentation skills.

COURSE DESCRIPTION:

Every student shall have to deliver a Seminar on a recent topic related to Environmental Sciences. Seminar will be of 1 hr. duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/ Faculty members well in advance so that the same may be displayed on the notice board.

The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

COURSE OUTCOME:

The students will get better employability and communication skills

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 207A

SUBJECT NAME: EVS - LAB III (WATER AND SOIL ANALYSIS)

NO. OF CREDITS: 3

M SC SEMESTER II			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

COURSE OBJECTIVES:

The objective of the course is to train the students in analysis of various environmental pollutants/parameters present in water and soil.

List of Experiments

1. Study of Physical characteristics of water: Colour, Odour, Turbidity, Temperature.
2. Determination of pH of water/soil sample.
3. Determination of conductivity/TDS of the water/soil sample.
4. Determination of salinity of the water/soil sample.
5. Determination of ORP of the water/soil sample.
6. Determination of alkalinity of the water/soil sample.
7. Determination of Dissolved Oxygen of given water sample by Winkler's method.
8. Determination of Fluoride content in the water sample by Spectrophotometric method.
9. Estimation of Nitrate in water sample by Spectrophotometric method.
10. Estimation of Sulphate in water sample by using Nephelometer.
11. Determination of Total Kjehldahl Nitrogen (TKN) in water/soil sample.
12. Determination of total organic carbon of a soil sample.
13. Determination of C:N ratio of a soil sample.
14. Determination of sulphate reducing bacteria in a given sample of water.

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.

COURSE OUTCOME:

The students will get first hand training on water and soil analysis and the skills acquired can be used in planning of the various treatment methodologies.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 208A

SUBJECT NAME: EVS - LAB IV (AIR POLLUTION SAMPLING AND ANALYSIS)

NO. OF CREDITS: 3

M SC SEMESTER II			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

COURSE OBJECTIVES:

The objective of the course is to train the students in analysis of various environmental pollutants/parameters present in air. They will also get the knowledge about vehicular emission testing.

List of Experiments

1. To study principle, components and working operation of Respirable dust sampler/High volume sampler.
2. Calibration of flow meters for high volume air sampler.
3. Study of TSPM in ambient air.
4. Study of PM_{10} and $PM_{2.5}$ in ambient air.
5. Study the efficiency of the filter media for particulate matter.
6. Study of plume behavior relation with wind velocity in your surrounding area.
7. Study the effect of different air pollutants on plants in your surrounding area.
8. Determination of NOx from ambient air using Respirable dust sampler/High volume sampler.
9. Determination of SOx from ambient air using Respirable dust sampler/High volume sampler.
10. Sampling and analysis of SPM in stationary sources.
11. Vehicular emission testing.
12. Determination of level equivalent values at a given place using Sound Level Meter.
13. Sampling and Analysis of noise in industrial, residential and commercial zones.

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.

COURSE OUTCOME:

The students will be able to perform air quality measurements in different areas and help in management plans.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 301A

SUBJECT NAME: INDUSTRIAL WATER AND WASTEWATER TREATMENT

NO. OF CREDITS: 4

M SC SEMESTER III			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The prime objective of the course is to elucidate the latest developments in treatment technologies and their application in diverse pollution sources including industries. The students will be given knowledge about the origin of wastewater generation and principles of various processes applicable to industrial water and wastewater treatment. The students will be able to identify the best applicable technologies for wastewater treatment.

UNIT-I: INDUSTRIAL WASTEWATER TREATMENT

Types of industrial pollutants, Industrial wastewater characterization, List of green, orange and red industries, Standards of disposal of industrial wastes, MINAS, Industrial Estate planning.

Different steps in the treatment of industrial waste (equalization, neutralization, sedimentation, oil separation, flotation, coagulation), biological oxidation - removal of organics (sorption, stripping, biodegradation).

UNIT-II: ADVANCED WASTEWATER TREATMENT-I

Advanced wastewater treatment processes - Nutrient removal – nitrification, denitrification, ANAMMOX, SHARON, CANON process, Biological phosphate removal (BPR); Membrane processes - Fundamentals, membranes – types, classifications, microfiltration, ultrafiltration, nanofiltration and reverse osmosis, electrodialysis, Ion exchange; Advanced oxidation process: Photocatalysis, ozonation – ozone/UV, ozone/hydrogen peroxide, hydrogen peroxide/UV, applications.

CETP: Requirement and objectives of CETP, Planning and management of CETP facilities for small-scale industries.

UNIT-III: ADVANCED WASTEWATER TREATMENT-II

Bioreactors for wastewater treatment - Membrane bioreactors (MBR), Moving bed biological reactors (MBBR), anaerobic baffled reactor (ABR), Sludge disintegration methods; sludge pretreatment – thermal, physical, chemical, mechanical and biological. Zero liquid discharge concept in Industries.

Energy recovery from wastewater: microbial fuel cells, microbial electrolysis cells, microbial desalination cell, biohydrogen production.

UNIT-IV: WASTEWATER REUSE AND RECOVERY

Manufacturing process description, Waste/emission generation sources, Waste characteristics, Pollution prevention options and treatment for the industries: Treatment, reuse and recovery of trade waste from (1) Textile Industries (2) Distilleries (3) Sugar (4) Paper and Pulp mills (5) Tanneries (6) Food Processing industries (7) Fertilizer Industry.

COURSE OUTCOMES:

On completion of the course, students will be able to

- Describe about various pollutants from different industries.
- Design treatment processes for various criteria pollutants.
- Decide suitable methods for treating the wastewaters under Indian conditions.
- Adopt the methods for reduction, recycling and reuse of industrial wastewater.

REFERENCES:

1. Thomous S. Spiro and William M. Stiglicini, Chemistry of The Environment, Prentice Hall of India Pvt. Ltd. (2002).
2. Nicholas P. Cherimisinoff, Biotechnology for Waste and Waste Water Treatment, Prentice Hall of India Pvt. Ltd. (2001).
3. Jarry A. Nathanson, Basic Environmental Technology, 4th ed ,Prentice Hall of India Pvt. Ltd. (2003).
4. W.Wesley Eckenfelder, Indusrtrial Water Pollution Control, 2nd ed., Tata Mc-Graw Hill Book Company (1989).
5. Crittenden, J. C., Trussell, R. R. and Hand D. W. (2005). *Water treatment: principles and design,*2nd edition, Wiley Publishers, USA.
6. Judd S (2011). *The MBR book: principles and applications of membrane bioreactors for water and wastewater treatment* 2nd edition,Butterworth-Heinemann publishers, UK.
7. Okafor N. (2011). *Environmental microbiology of aquatic and waste systems, 1st edition,* Springer publication, USA.
8. Parsons, S. (2004). *Advanced oxidation processes for water and wastewater treatment,* IWA Publication, London, UK.
9. Tchobanoglous G, Burton, F. L., Stensel H. D. (2002). *Wastewater engineering: treatment and reuse*, McGraw-Hill Science, USA.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 302A

SUBJECT NAME: SOLID AND HAZARDOUS WASTE MANAGEMENT

NO. OF CREDITS: 4

M SC SEMESTER III			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The course will provide the basic knowledge of solid waste in terms of characteristics and composition. The students will get the knowledge of legal, institutional and financial aspects of management of solid wastes with a focus on special categories of solid waste. The students will become aware of environmental and health impacts of solid waste management. Further, the course will provide the understanding of engineering, financial and technical options for waste management.

UNIT - I: SOLID WASTE GENERATION AND COLLECTION

Solid wastes: Definition, types, sources, classification and composition of solid waste, and impact on environmental health. Waste generation rates. Collection and storage of municipal solid wastes, Handling and segregation of wastes at source. Concepts of waste reduction, recycling and reuse.

UNIT - II: SOLID WASTE TREATMENT AND DISPOSAL

Solid waste processing technologies, Incineration, Combustion, Stabilization, Solidification, chemical fixation, encapsulation, Composting, Vermicomposting, Energy from waste - Biogasification - Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill bioreactors

Burning, open dumping - problems, Landfill – site selection, Sanitary and secured – structure, design,construction, operation and closure. Landfill leachate and gas management, Landfill bioreactors.

Recycling of household and commercial waste, recycling of paper, recycling of tire, recycling of plastics.

UNIT - III: HAZARDOUS WASTE MANAGEMENT

Hazardous waste: Definition, sources, classification, collection, segregation, characterization, Treatment and disposal.

Radioactive wastes: Definition, sources, classification, collection, segregation, Treatment and disposal.

E waste: Definition, sources, classification, collection, segregation, Treatment and disposal.

Biomedical wastes: Definition, sources, classification, collection, segregation, Treatment and disposal.

UNIT - IV: SOLID WASTE MANAGEMENT LEGISLATION

Solid waste management plan, Solid Waste (Management and Handling) Rules, 2000, 2016 and amendments if any, Biomedical Waste (Management and Handling) Rules, 2016; Notification of Ash utilization 1999, 2003, 2009, 2015 and amendments if any, Plastic Waste Management Rules, 2016; E-Waste Management Rules, 2016; Bio-Medical Waste Management Rules, 2016; Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; Construction and Demolition Waste Management Rules, 2016.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Do sampling and characterization of solid waste.
- Understand various concepts related to solid waste management.
- Acquire the knowledge related to hazardous waste management.
- Apply steps in solid waste management - waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques.
- Get acquainted with the legislation related with solid waste management.

REFERENCES:

1. Solid Waste Management Manual CPCB, New Delhi.
2. Ecotechnology for Pollution Control and Environmental Management by Trivedy R.K. and Arvind Kumar.
3. Williams, Paul T. (2013) Waste treatment and disposal, John Wiley Publishers.
4. Johri, Rakesh (Ed.), (2009) E-waste : Implications, regulations and management in India and Current global best practices, TERI press.
5. Letcher, Trevor M. (Ed.) (2011) Waste: A handbook for management, Academic Press London.
6. Sahai, Sushma (2009) Bio- medical waste management, APH Publishing.
7. Rosenfeld, Paul E., (2011) Risks of hazardous wastes, Elsevier London.
8. R E Hester (ed.); Roy M Harrison (ed.) (2008) Electronic waste management: design, analysis and application, Cambridge Royal Society of Chemistry.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 303A

SUBJECT NAME: NATURAL RESOURCE MANAGEMENT

NO. OF CREDITS: 4

M SC SEMESTER III			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The course is designed to provide information to the students about the natural resources of the planet Earth and causes of their depletion. The course also fosters an understanding of fundamental environmental issues with a focus on resource conservation and management for future use.

UNIT-I: FOREST RESOURCES

Natural resources: Definition, classification of natural resources, natural resource degradation and conservation, Environmental impacts of resource depletion.

Forest Resources: Forest cover of India and world, forest types, functions of forest, Conservation of forests, forestry programmes – social forestry, farm forestry, urban forestry, community forestry, deforestation, Exploitation of forest resources, Afforestation, Desertification, Forest policy.

UNIT-II: WATER AND MARINE RESOURCES

Water Resources: Surface, ground water, Rivers and Lakes in India, hydrological cycle, Ground water depletion, Water logging and salinity, Water Conservation and management techniques, Rain water harvesting, Watershed management, River action plans - Ganga and Yamuna action plan, Interlinking of rivers, conflicts over water.

Marine resources: Introduction to marine resources, Factors controlling abiotic resources and their distribution - polymetallic manganese nodules, phosphorites, hydrocarbons, beach placers evaporates, rare metals, corals, pearls and shells. Prospecting and mining of the ocean floor, Management of marine resources. Policies and acts related to ocean and land.

UNIT-III: LAND AND MINERAL RESOURCES

Land resources: Land degradation due to mining, exploration, industrialization, irrigation and natural disasters; Soil Erosion, Loss of soil fertility, Restoration of soil Fertility, Soil Conservation Methods, Wasteland reclamation, Organic farming, green manuring, Wetland – definition, classification, functions, ecological importance and conservation.

Mineral resources: Mineral resources of India – Use and exploitation; mineral exploration, extraction; environmental impacts of extraction; Restoration of mining lands.

UNIT-IV: BIORESOURCES

Definition, Types and significance of biodiversity, values and threats, biodiversity conservation strategies; Bioprospecting. Biopiracy, REDD+; Conventions and protocols. Wildlife resources and conservation measures

Human resources – population explosion, urbanization, industrialization, slums, poverty.

COURSE OUTCOMES:

After completing this course, the students will be able to:

- Apply principles of chemical, biological, and physical systems to address natural resource and environmental issues.
- Demonstrate the ability to draw conclusions and make recommendations based on an interdisciplinary understanding of natural and human systems.
- Able to effectively apply various steps for conservation of natural resource.

REFERENCES:

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

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 304A

SUBJECT NAME: ENVIRONMENTAL NANOTECHNOLOGY

NO. OF CREDITS: 4

M SC SEMESTER III			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

This course covers the importance of all different aspects and effects of environmental nanotechnology. The students will be imparted basic knowledge on various synthesis and characterization techniques involved in nanotechnology and the methods by which nano-materials can be useful in environmental applications. The students will also get the understanding of toxicology related to nanotechnology.

UNIT-I: SYNTHESIS AND ADVANCED CHARACTERIZATION OF NANOMATERIALS

Physical and chemical method of synthesis for SWCNT, MWCNT, Metal nanoparticles and Metal oxide and Chalcogenide nanoparticles. Biologically Synthesized Nanoparticles, Nanostructures and Synthetic Nanocomposites - Protein-Based Nanostructure Formation - DNA-Templated Nanostructure Formation - Protein Assembly - Biologically Inspired Nanocomposites

UNIT-II: PROPERTIES OF NANOMATERIALS

Carbon nanotubes: electrical properties, vibrational properties, mechanical properties and applications of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis – mechanical reinforcement. Semiconductor nanostructures – electronic properties, optical behavior and quantum confinement, characterization of semiconductor nanostructures.

UNIT-III: NANOMATERIALS IN ENVIRONMENT

DNA, protein, molecular motors, aerosols, self-assembly and natural surfactants, Identification and characterization of Hazardous waste, Nano Pollution, Air, Water and Soil Contaminants.

Environmental Nano Remediation Technology - Nanotechnology for water remediation and purification: nZVI, Ag, Photofenton process, TiO2 and its modification for efficient photodegradation, Nano Filtration for treatment of waste – removal of organics & inorganics and pathogens, Nanomembranes in Drinking water treatment, Nanomembranes in Sea desalination. Application of Nanomaterial in microfuelcell, fuel Cell, hydrogen storage.

UNIT-IV: ENVIRONMENTAL NANOTOXICOLOGY

Fate of nanomaterials in environment, environmental life cycle of nano materials, environmental and health impacts of nano materials, toxicological threats, eco-toxicology, exposure to nano particles – biological damage, threat posed by nano materials to humans, environmental reconnaissance and surveillance.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

- Apply various nanomaterials for environmental management.
- Synthesize various nanomaterials.
- Understand environmental risks of nanomaterials and their management.
- Acquire knowledge about toxicology due to nanomaterials.

REFERENCES:

1. Balaji S., (2010). *Nanobiotechnology,* MJP Publishers,Chennai.
2. Poole, C. P. Jr. and Owens F. J. (2009). *Introduction to nanotechnology*, Wiley India, New Delhi.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 305A

SUBJECT NAME: NATURAL HAZARDS AND DISASTER MANAGEMENT

NO. OF CREDITS: 4

M SC SEMESTER III			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

This course is designed to familiarise the students with various concepts of disasters and their management which include causes and effects of disaster, types, predictability, preparedness, nature of damage caused and disaster mitigation, pre and post disaster management. The course will upgrade the information, knowledge and skill of the students about natural hazards which in turn will enable them to act with confidence in pre and post disaster situations.

UNIT-I: INTRODUCTION TO DISASTERS

Introduction to Natural and Manmade Disasters; Floods –nature and frequency of flooding, flood hazards, urbanization and flooding, flood hydrographs, Drought, Landslides; Coastal hazards – tropical cyclone, coastal erosion, sea level changes, coastal zone management; Earthquakes - Seismic waves, quake resistant buildings and dams; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters.

UNIT-II: RISK ASSESSMENT

Pre-Disaster Management activities; Hazard and vulnerability analysis; capability assessment; emergency/ contingency planning and post-disaster management activities; Development planning, types of plans, MBO, SWOT analysis.

UNIT-III: GEOINFORMATICS IN DISASTER MANAGEMENT

Role of GPS, GIS and Remote Sensing in disaster management - Landslides, Volcanoes, Tsunami, Cyclones, Urban and Forest fires, Landslides; Decision-making models and processes; Hazard monitoring, tracking and modelling; Early warning systems; Indian space programme, future satellites for disaster management; Case studies.

UNIT-IV: LEGISLATIONS AND POLICIES FOR DISASTER MANAGEMENT

India Disaster Resource Network; Organization and structure for Emergency Management; Principles and Practice of Disaster Relief and Recovery; Disaster management policy; Important

statutes with provisions relevant to Disaster Management; Role of legislations in Disaster Management, Scope of Disaster Management Law with reference to Disaster Management Bill 2005, National Green Tribunal, Environment Protection Act, 1986, including Hazardous Substances Rules, Explosives Act, 1872, Explosive Substances Act, 1908, Mines and Minerals (Regulation and Development) Act, 1957, Insecticides Act, 1968, Atomic Energy Act, 1962, Factories Act, 1948; Local Administration and disaster risk reduction; Relief and Rehabilitation.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Define and describe disaster management, hazard, emergency, disaster, vulnerability, and risk.
- Identify and describe the types of natural and non-natural disasters and the implications of disasters on environment.
- List and describe the main hazards to which our region is, or may be, vulnerable.
- Describe briefly how the effects of disasters can be reduced on vulnerable groups.
- Know the legal framework for disaster management.

REFERENCES:

1. William H. Dennen and Bruce R. Moore, WCB Publishers, Iowa, 1986.
2. John M. Wallace and Peter V. Hobbs, Atmospheric Science: An Introductory Survey, Academic Press, New York, 1977.
3. Egbort Bocker and Rienk Van Grondille, Environmental Physics, John Wiley & Sons Ltd., 1999.
4. Barbar W. Murk et. al., Environmental Geology, John Wiley & Sons, New York, 1996.
5. Bohle, H. G., Downing, T. E. and Watts, M. J. Climate change and social vulnerability: the sociology and geography of food insecurity, Global Environmental Change. No.4, pp. 37-48.
6. Collins Larry R. and Schneid Thomas D., Disaster Management and Preparedness, Taylor and Francis 2000
7. Goel S.L. and Kumar Ram, Disaster Management, Deep and Deep Publications, 2001
8. Living With Risk: A global Review Of Disaster Reduction Initiatives 2004 Vision, United Nations, 2004.
9. Parasuraman S., India Disasters Report: Towards a Policy Initiatives, Oxford University Press, 2004.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 306A

SUBJECT NAME: SEMINAR

NO. OF CREDITS: 2

M SC SEMESTER III			SESSIONAL : 50
L	T	P	FINAL EXAM: -
0	0	2	TOTAL : 50

COURSE OBJECTIVES:

The objective of the course is to provide the students exposure to the recent developments and to improve the student's presentation skills.

COURSE DESCRIPTION:

Every student shall have to deliver a Seminar on a recent topic related to Environmental Sciences. Seminar will be of 1 hr. duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/ Faculty members well in advance so that the same may be displayed on the notice board.

The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

COURSE OUTCOME:

The students will get better employability and communication skills.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 307A

SUBJECT NAME: EVS – LAB V (INDUSTRIAL WATER AND WASTEWATER ANALYSIS)

NO. OF CREDITS: 3

M SC SEMESTER III			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

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. Potentiometric determination of pH of water/wastewater samples.
2. Conductivity of water and wastewater samples using conductivity and TDS meter.
3. Determination of Dissolved oxygen of a water sample.
4. Determination of BOD of a wastewater sample.
5. Determination of COD of a wastewater sample.
6. Working, standardization of flame photometer and plotting calibration curve for metal ions.
7. Determination of Na and K in given water sample by using Flame photometer.
8. Comparison of Ca and Mg in water sample by using Flame photometer and titration method.
9. Determination of Phosphate in given water sample by using Spectrophotometer.
10. Determination of the concentration of Oil & Grease in given water sample.
11. Analysis of an industrial effluent for water quality parameters and report writing.
12. A visit to an ETP/STP in the city and report writing.

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.

COURSE OUTCOME:

The students will be able to design various experiments for reducing the pollution load from wastewater streams.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 308A

SUBJECT NAME: EVS - LAB VI (WASTE MANAGEMENT)

NO. OF CREDITS: 3

M SC SEMESTER III			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

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 physical composition of solid wastes.
2. To determine moisture content, pH and conductivity of given solid waste sample.
3. To determine calorific value of solid waste/fuel.
4. To determine the ash content and organic carbon content of given solid waste material.
5. To determine Nitrogen content in given solid waste material.
6. To determine Phosphorus content in given solid waste material.
7. To determine potassium content in given solid waste material.
8. To determine C/N ratio of given solid waste material.
9. Composting/Vermicomposting Experiments for the management of Solid Organic Waste.
10. To study and write a report on solid waste collection, transportation, treatment and disposal methods of your city.
11. A visit to normal and secured landfill site, biological composting/vermicomposting units in the city and report writing.

    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.

COURSE OUTCOME:

The students will be able to design various experiments for management of solid waste.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 401A

SUBJECT NAME: ENVIRONMENTAL IMPACT ASSESSMENT AND AUDITING

NO. OF CREDITS: 4

M SC SEMESTER IV			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

This course aims at apprising the students with an insight into environmental impact assessment methodologies, environmental settings, prediction, evaluation of impacts and their mitigation plan. The students will be inculcated the capabilities to interpret environmental management plans and EIA documents. A comprehensive understanding of the need and procedures for environmental auditing will be provided to the students.

UNIT - I: ENVIRONMENTAL IMPACT ASSESSMENT

Environment Impact Assessment (EIA) - Principles, Origin, development, types, issues, problems and limitations, environmental management plan, environmental impact statement (EIS), Strategic Environmental Assessment (SEA), EIA guidelines (1994) and notifications (Govt. of India 2006), Scope of EIA in project planning and implementation, Indian directions of EIA.

UNIT – II: EIA METHODOLOGY

Components of EIA, EIA methodology – project screening, scoping, base line data, impact identification, prediction, evaluation, mitigation. Assessment techniques – cost benefit analysis, analysis of alternatives, methods of prediction matrices, networks, checklists and overlays and assessment of impacts – air, water, soil, noise, biological, social, cultural, economical, environmental factors.

EIA standards and guidelines, public participation- procedure of public hearing, presentation, review and decision making. Quality control – trends in EIA practice, evaluation criteria, expert system in EIA, use of regulations. Documentation and monitoring – Generic structure of EIA Document, planning, collection, use of display materials, team writing, checklist, environmental monitoring guidelines and policies, post audit.

UNIT -III: CASE STUDIES OF ENVIRONMENTAL IMPACT ASSESSMENT AND RISK ANALYSIS

Environmental Appraisal procedures in India, Impact identification methods. Environmental impacts of mining industry ; nuclear power plant; textile industry; petroleum refining; fertilizer

industry ; Case study – EIA of Hydroelectric dam and river valley projects; thermal power plants. Risk assessment in EIA.

UNIT - IV: ENVIRONMENTAL AUDITING

Definition and types of audits, Guidelines for environmental auditing, methodologies for Environmental Auditing, Matrix methods and Battelle method of auditing, Types of projects requiring Environmental Clearance, EAC, EIA case studies, Legal requirements for environmental auditing. Restoration and rehabilitation technologies, Environmental planning, urban planning, rural planning and land use pattern.

COURSE OUTCOMES:

On completion of the course, the candidate will be able to:

- Understand the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects.
- Understand the legal requirements for getting environmental clearance for new projects.
- Know the requirements to become EIA consultant.
- To be a part of EIA team to conduct EIA study for various projects.
- Acquire basic skills to take up environmental auditing and lifecycle analysis at specific industries.

REFERENCES:

1. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co., New Delhi. 2006.
2. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.
3. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006.
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York.
5. Fischer, T. B. (2007). Theory and Practice of Strategic Environmental Assessment, Earthscan, London.
6. Lawrence, D. P. (2003) Environmental Impact Assessment: practical solutions to recurrent problems, John Wiley & Sons, Hoboken NJ.
7. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London.
8. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford.
9. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London.
10. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester
11. Wood, C. (2003) Environmental Impact Assessment – A Comparative Review, Prentice Hall, London.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 402A

SUBJECT NAME: ECOTOXICOLOGY AND OCCUPATIONAL SAFETY

NO. OF CREDITS: 4

M SC SEMESTER IV			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The objective of the present course is to acquaint the students with various aspects of environmental toxicology from molecular to ecosystem level. The students will be taught about the health hazards and the safety measures to be followed in industrial environment. They will get to know about the methods of prevention and control of occupational health diseases, accidents and other hazards.

UNIT-I: INTRODUCTION TO TOXICOLOGY

Definitions, Classification, Origin and General Nature of Toxicants in Environment, concepts; Toxic chemicals in the environment - air, water & their effects, Basic Probit analysis; Toxicants – Toxicity, mechanism of toxicity - Acute, sub-acute, chronic, dose effect, LD 50, LC 50 and response safe limits, IT, IC, LD80, LD90, LCIC, Dose response relationship, concentration response relationship, Influence of route of administration, determination of toxicity of chemicals.

UNIT-II: TOXIC MECHANISMS

Bioaccumulation and Biomagnification of toxic materials in food chain, detoxification, bioconcentration, Toxicology of major pesticides and heavy metals (Aluminium, arsenic, cadmium, chromium, lead and mercury) - biotransformation, biomonitoring, residual effects; bioindicator– definition, groups and examples.

UNIT-III: BIOASSAYS

Concepts, types, characteristics and significance of bioassay, Bioassay test models and classification - Microbiol, algal, invertebrates and alternative toxicity tests, Immunotoxicity, histotoxicity, cell toxicity. Ecotoxicology – Legislative perspectives.

UNIT-IV: OCCUPATIONAL HEALTH

Occupational hazards in industries and other sectors, Safety requirements and Measures; Occupationally induced illness, non-occupational illness, discomfort at work, Occupational diseases- Pneumoconiosis, Silicosis, Anthracosis, Byssinosis, Bagasosis, Asbestosis, Farmer's lung, Metal poisoning, Occupational cancer, Occupational dermatitis; Radiation, fire and explosion hazards Hazards; occupational health practice; risk assessment techniques for accidental release of toxic and inflammable materials; Role of WHO in occupational health. Occupational health Standards - ISO.

COURSE OUTCOMES:

After completion of this course, the students will:

- Know about the environmental toxicants and their effects.
- Describe the common work-related diseases and accidents in occupational setting.
- Know various means to ensure the protection, promotion and maintenance of the health of the employee.
- Describe industrial legislations enacted for the protection of employees health at workplace.

REFERENCES:

1. Tatiya, Ratan raj (2013) Elements of industrial hazards: Health, safety, environment and loss prevention Taylor and Francis.
2. Theodore, Louis (2012) Environmental health and hazard risk assessment: Principles and calculations, CRC Press
3. Wong, Ming H. (Ed.) (2013) Environmental contamination: Health risks and ecological restoration, CRC press
4. Ware, George M.(Ed) (2007) Reviews of environmental contamination and toxicology. Vol. 190: Continuation of residue reviews, Springer Publishers
5. Manahan, Stanley E. (2013) Fundamentals of environmental and toxicological chemistry: Sustainable sciences, CRC press

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 403A

SUBJECT NAME: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

NO. OF CREDITS: 4

M SC SEMESTER IV			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper has two parts. Part-1 has 10 questions each of equal marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES:

The aim of this course is to make students understand the basic techniques of biotechnology and their applications for bioremediation of contaminants and conservation of biodiversity. The students will be able to understand the recent trends in environmental biotechnology and use of phytotechnology for remediation of environmental contaminants.

UNIT-I: INTRODUCTION

Definition and importance of Environmental microbiology and biotechnology, Biosensors in detection of environmental pollutants: Biomarkers, Biosensors of pollution- BOD, ammonia, methane, Role of microbes in sequestering carbon dioxide.
Role of biotechnology in conservation of species: *in-situ* and *ex-situ* conservation through gene banks.

UNIT-II: BIODEGRADATION

Recalcitrance of xenobiotics, Biodegradation of Halogenated hydrocarbons, Polycyclic aromatic hydrocarbons and Pesticides. Emerging Environmental Biotechnologies: Application of microbial enzymes, Biomembrane reactors.

UNIT-III: BIOREMEDIATION OF POLLUTED ENVIRONMENTS

Environmental applications of bioremediation, types of bioremediation, mechanisms of microbial metal resistance and detoxification, bioremediation of oil spills, limitations of bioremediation. Biotechnology and radioactive pollution: Bioleaching and Biosorption. Phytoremediation: Phytoremediation of xenobiotics and bioaccumulation of metals using plants.

UNIT-IV: DEVELOPMENT OF BIODEGRADABLE AND ECO-FRIENDLY PRODUCTS

Fermentation technology; biomass production; Biofuel and Biodiesel-plant derived fuels, bioethanol, biohydrogen; biofertilizers; biopesticides; bio-polymers. Bioethics in Environmental biotechnology: Bioethics issues - Genetically engineered microbes and GM Crops.

COURSE OUTCOMES:

After completing this course, the students will be able to:

- Understand the basic techniques of biotechnology and their applications for detection of environmental contaminants.
- Describe emerging environmental biotechnologies for biodegradation of compounds.
- Apply the concepts for bioremediation of contaminated sites.
- Acquire the knowledge for development of biodegradable and eco-friendly products.

REFERENCES:

1. A. Scragg. (2005). Environmental Biotechnology, 2nd Edition, Oxford University Press.
2. B. Rittman, P. L. McCarty. (2000) Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill.
3. I. S. Thakur. (2006). Environmental Biotechnology: Basic Concepts and Applications. I K International Publications.
4. B.C. Bhattacharya and R. Banerjee (2007). Environmental Biotechnology. Oxford University Press, 2007.
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M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 404A

SUBJECT NAME: EVS – LAB VII (POLLUTION MANAGEMENT)

NO. OF CREDITS: 3

M SC SEMESTER IV			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	6	TOTAL	: 100

COURSE OBJECTIVES:

The objective of the course is to train the students in analysis of various environmental pollutants/parameters present in air. They will also get the knowledge about vehicular emission testing.

List of Experiments

1. Estimation of heavy metals using spectrophotometer.
2. To synthesize the low cost adsorbent using a waste material.
3. Removal of heavy metals from wastewater by Adsorption methods.
4. Removal of dye from a textile industry effluent by Adsorption methods.
5. Flocculation studies of wastewater samples.

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.

COURSE OUTCOME:

The students will be able to perform air quality measurements in different areas and help in management plans.

M. SC. ENVIRONMENTAL SCIENCES

CODE: EVS 405A

SUBJECT NAME: PROJECT WORK

NO. OF CREDITS: 8

M SC SEMESTER IV			INTERNAL ASSESSMENT	: 30
L	T	P	END-SEMESTER ASSESSMENT	: 70
0	0	16	TOTAL	: 100

COURSE OBJECTIVE:

The objective of the course is to make students know how to apply the principles learnt from various courses to solve real time problems related to environment.

COURSE DESCRIPTION:

Project Work**:** Every student will be required to undertake project work based on related areas of Environmental Sciences. The project report will be submitted in the form of dissertation and will be presented for evaluation at the end of semester by external experts.

COURSE OUTCOMES:

- The students will get confidence to solve challenging problems related to environment.
- The decision making and management skills of students will be enhanced due to practical exposure to environmental issues in field conditions.