Master of Science

Discipline: Environmental Science

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

SWAMI VIVEKANAND SUBHARTI UNIVERSITY, MERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE MEERUT
DEAN

Dr. Adesh

	Course Code	Course Name	Course Type	Teaching load/week				Credits	Evaluation Scheme				
									Sessional Exams			ESE	Total
				L	T	P	Total		CT	AT	Total		
Semester- I	MSC-EVS-101	Instrumental Techniques For Environmental Analysis	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS-102	Application of Biostatistics and Computer in Environmental Science	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS-103	Ecology and Biodiversity	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS-104	Environmental Geosciences	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS-151	PRACTICAL I: (BASED ON MSC-EVS-101 AND 102)	Core Course	0	0	4	4	4	20	10	30	70	100
	MSC-EVS-152	PRACTICAL II: (BASED ON MSC-EVS-103 AND 104)	Core Course	0	0	4	4	4	20	10	30	70	100
	MSC-EVS-153	SEMINAR	Qualifying Course	1	0	0	1	0	0	0	50	0	50
		TOTAL		**16**	**0**	**8**	**24**	**24**	**120**	**60**	**180**	**420**	**600**
Semester- II	MSC-EVS -201	Air and Noise: Pollution and Abatement	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -202	Water Pollution and Control Technologies	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -203	Solid Waste Handling and Management	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -204	Environment, Health and Safety	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -251	Practical III: (Based on MSC-EVS-201 & 202)	Core Course	0	0	4	4	4	20	10	30	70	100
	MSC-EVS -252	Practical IV: (Based on MSC-EVS-203 & 204)	Core Course	0	0	4	4	4	20	10	30	70	100
	MSC-EVS -253	Seminar	Qualifying Course	1	0	0	1	0	0	0	50	0	50
		TOTAL		**16**	**0**	**8**	**24**	**24**	**120**	**60**	**180**	**420**	**600**
Semester- III	MSC-EVS -301	Sustainable Environmental Development and Disaster Management	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -302	Industrial Water and Wastewater Treatment	Core Course	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -303	Environmental Management Systems, Environmental, Impact Assessment and Environmental Audit	Elective Course **(Select Any One)**	4	0	0	4	4	20	10	30	70	100
	MSC-EVS -304	Environmental Laws											
	MSC-EVS -305	Soil and Solid Waste Management											
	MSC-EVS -306	Environmental Issues and Legislation	Elective Course **(Select Any**	4	0	0	4	4	20	10	30	70	100

MSC-EVS -307	Entrepreneurship	One)											
MSC-EVS -308	Environmental Awareness, Policies and Laws												
MSC-EVS -351	Practical V: (Based on MSC-EVS-301and 302	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-EVS -352	Practical VI: (Based on MSC-EVS-303/ 304/305 & -306/307/308)	Course	0	0	4	4	4	20	10	30	70	100
MSC-EVS -353	Seminar	Qualifying Course	1	0	0	1	0	0	0	50	0	50
	Total		**16**	**0**	**8**	**24**	**24**	**120**	**60**	**180**	**420**	**600**

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme		Subject Total
				L	P	T	Total		Dissertation	Viva-Voice and Presentation	
Semester IV	M.Sc.-EVS-451	Project	Core Course	0	20	0	20	20	400	100	500
	M.Sc.-EVS-452	Seminar	Qualifying	0	1	0	1	1	0	100	100
			Total	0	20	0	20	21	500	100	600

Master of Science (M.Sc.) (Environmental Science)

Program Educational Objectives (PEOs)	
PEO1	The students could get employment opportunities in Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB), Research Institutions, Colleges, Universities and Non-governmental organizations.
PEO2	After successful completion of the course, the students could get job opportunitiesin urban and rural environmental mitigation and awareness including social forestry programs, bio-fertilizer and bio-pesticide industries, waste management and organic farming divisions funded by National, International and Regional agencies.
PEO3	The students could get employment perspectives in R & D laboratories of waste water treatment plants, metal, chemical and textile effluent treatment plants, municipal solid waste management units and waste management in biomedical industries and hospitals.
PEO4	The students could find employment opportunities in agro industries, forest departments, water harvesting and watershed management sectors, bio- resource utilization and biodiversity conservation organizations, food and feed Industries, environment friendly and integrated livestock management sectors.
PEO5	Students also having the immense opportunities to pursue higher studies in various research fields such as environmental pollution, environmental chemistry, waste management and bioremediation, environmental microbiology, waste water treatment, recycle, reuse and management, sustainable environmental food security, bio-resource utilization and biodiversity conservation, functional and ecosystem ecology, environmental toxicology, agro-waste ecosystem, non-biodegradable synthetic chemicals and polymers in environment, occupational health and industrial safety, environment analytical techniques, environmental impact assessment, remote sensing and geographical information system, environmental biotechnology, carbon sequestration, natural disaster management and mitigation, climate change, marine pollution and resources utilization, restoration of different ecosystems, renewable and green energy and environmental law, policies and auditing.

Master of Science in Environmental Science (CBCS)

Year: I **Semester: First (I)**

Programme/Class: MSc Environmental Science	Year :First	Semester: I
Course Code: **MSC-EVS-101**	Course Title: **Instrumental Techniques For Environmental Analysis**	

Course outcomes: After completing the course the student will be able to:

- Understand the problem and identify suitable techniques to analyze the environmental samples.
- Explain and use suitable sampling methods for collection of different samples to perform physical, chemical and biological characterization of environmental pollutants.
- Appraise the principles, working and applications of the instrumental techniques used for analysis of physical, chemical and biological entities.
- Differentiate between the various analytical methods and capable to design method required for quantitative and qualitative analysis of environmental components.

Credits: 4 **Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**BASICS OF ANALYTICAL APPROACH** ***Analytical Approach:*** Defining of Problem and Designing of Analytical Method; Sampling: Types and Methods for Solid, Liquid and Gaseous Matrix; Sample Storage; Sample Preparation; Measurement and Assessing of Data; Method Validation and Documentation; ***Wet Chemical Methods:*** Titrimetry; Gravimetry	15
II	**SPECTROMETRIC ANALYTICAL TECHNIQUES** UV- Visible spectrophotometer, Flame photometry, atomic absorption spectrophotometry; Plasma Emission Spectroscopy; X-Ray Spectroscopy (X-Ray Fluorescence, X-Ray Diffraction); Fourier- transform Infrared Spectroscopy (FTIR); Nephelometry and Turbidimetry	15
III	**UNIT-III: CHROMATOGRAPHIC TECHNIQUES** Chromatographic Techniques (Paper Chromatography, Thin Layer Chromatography, Gas Liquid Chromatography, High Performance Liquid Chromatography, Ion-exchange Chromatography); Electrophoresis	15
IV	**UNIT IV: MICROSCOPY TECHNIQUES** Optical Microscopy (Brightfield and Darkfield, Phase Contrast, Fluorescence, Confocal); Electron Microscopy (Scanning and Transmission Electron Microscopy)	15

Suggested Books:

1. Hussain, C. M., & Kecili, R. (2019). Modern Environmental Analysis Techniques for Pollutants. Elsevier.
2. Khopkar, S.M. (2015). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
3. Mitra, S., & Kebbekus, B. B. (2018). Environmental Chemical Analysis. CRC Press.
4. Robinson, J. W., Frame, E. M. S., & Frame, G. M. (2014). Undergraduate Instrumental

Analysis. CRC Press, New York

5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis. Cengage learning.
6. Willard, H.H., Merritt, L.L, Deen, J.A. and Settle, F.A. (2015). Instrumental Methods of Analysis. CBS Publishers and Distributers, New Dehi.
7. Patnaik, P. (2017). Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes. CRC Press.

SUGGESTED WEB SOURCES:

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. https://nptel.ac.in/courses/103/106/103106162/
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
4. https://swayam.gov.in/

Programme/Class: MSc Environmental Science	Year: **First**	Semester: **I**
Course Code: MSC-EVS-102	Course Title: **Application of Biostatistics and Computer in Environmental Science**	

Course outcomes: After completing the course the student will be able to:

- Understand the need of statistics
- Understand the arrangement of data for the application of statistics
- Apply the various statistical tools.
- In the Interpretation of obtained value of statistical measures.

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**Data Collection and Analysis -I** ▪ Sampling types, Data: sources, structures, types and collection. ▪ Measurements of central tendency	12
II	**Data Collection and Analysis -II** ▪ Statistical Methods: Standard deviation and variance. Basic concepts: Measures of central tendency and deviations	12
III	**Application of Biostatistics in Analyses of Data** ▪ Types of Probability, Normal and Binomial Distribution. ▪ Hypothesis testing, significance and correlations: Linear models and regressions.	12
IV	▪ Multiple regressions. Difference among means: F-test: 1 way ANOVA; F-test: 2 way ANOVA., T-test FUZZI technology, Analytical Hierarchy Process	12

V	**Computer application & Web designing** ▪ Computer-based modeling: Linear, regression, validation and forecasting. ▪ Computer-based modeling for population and population studies. ▪ Computer application for environmental : Linear, regegression, validation and forecasting ▪ Introduction to database , networking, LAN,WAN , Website design	12

Suggested Books:

1. Robert S. and Rohlf J.(1997). Biometry, Freeman Press, New York, U.S.
2. Walpole, R. and Myers R. (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, New York, U.S.
3. Ott W.R. (1995). Environmental Statistics and Data Analysis, CRC Press.
4. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC Press
5. Ramsay F. and Schafer D. (1997). The Statistical Sleuth, Duxbury Press
6. Smith J. and Smith P.(2007) Environmental modeling and introduction. OxfordUniversity Press,UK, .
7. Jerrold H. Z.(1998). Biostatistical Analysis. Prentice Hall, New jersy, U.S.

Programme/Class: MSc Environmental Science	Year: **First**	Semester: **I**
Course Code: MSC-EVS-103	Course Title: **Ecology and Biodiversity**	

Course outcomes: After completing the course the student will be able to:

1. Demonstrate knowledge of ecological principles operating at different levels of organization.
2. Understand the concepts of ecosystems and compare them with real life processes.
3. Analyze components of population and community ecology.
4. Interpret ecological and social phenomena from a biodiversity view point and develop new conservation measures on new or endangered species in a given habitat.

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**INTRODUCTION TO ECOLOGY** Definition, subdivisions and scope, basic concepts of ecology, Autecology and Synecology, biological levels of organization-genes to biosphere, Interaction of ecological factors - Light, temperature, precipitation, humidity. Atmospheric gases, wind and fire, topographic and edaphic factors, adaptation, Ecological concepts of species (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors).	15
II	**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, Habitat, niche- concept and types, keystone species, Flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators, ecological succession - types and mechanism.	15

III	**ECOSYSTEM DYNAMICS** Introduction, kinds of ecosystem, structure and function of ecosystem, food chain, food web, trophic level, ecological pyramids, energy flow models, ecosystem productivity, methods of measuring primary productivity, Ecosystem stability and regulation, biogeochemical cycles- cycling of water and nutrients, Structure of some typical ecosystems - forest, desert, grassland, pond, marine, wetland, estuaries, cropland.	15
IV	**BIODIVERSITY** Definition, levels of biodiversity, measuring biodiversity, values of biodiversity, Hotspots of biodiversity, Biodiversity hotspots of India, threats to biodiversity. Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India. Endangered and threatened species, IUCN Categories of threatened species, Red data book, List of threatened flora and fauna in India. Biodiversity conservation; National and international efforts for wildlife and forest conservation, wetland conservation, Convention on Biodiversity.	15

Suggested Books:

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,
4. Asian Books, 2013.
5. Jorgensen, Sven Erik. Encyclopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands, 2008.
6. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management.
7. APH, New Delhi, 2009.
8. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi, 2009.
9. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis, 2009.
10. Odum, E.P., Barrick, M. and Barrett, G.W. Fundamentals of Ecology (5th Ed). Thomson Brooks/Cole Publisher, California, 2005.
11. Rana, S.V.S. Essentials of Ecology and Environmental Science (5th Ed), PHI Learning Pvt. Ltd, 2013.
12. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi, 2016.
13. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, Ne7thw York.
14. Smith, T.M and Smith, R.L. Elements of Ecology (8th Ed), Benjamin Cummings, 2012.
15. Vandermeer, John H., Riddle, B.R. and Brown, J.H. Population Ecology: First principle
16. (2nd Ed). Princeton University Press, 2013.
17. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). Ecology, Environment and Resource Conservation, S. Chand Publishing, New Delhi.

SUGGESTED WEB SOURCES:

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. https://www.iucn.org/
3. https://www.cbd.int/
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

Programme/Class: MSc Environmental Science	Year: **First**	Semester: **I**
Course Code: MSC-EVS-104	Course Title: **Environmental Geosciences**	

Course outcomes: After completing the course the student will be able to:

1. Understand the basics of the Earth's structure, composition and evolution of landforms CO2: Analyze the effects of meteorological parameters on the dispersion of pollutants.
2. Understand and apply the basic concepts of meteorology, climatology and oceanography for solving relevant environmental issues.
3. Identify the issues related to climate change, understand reasons and recommend remedial measures

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**EARTH PROCESSES** Earth Structure and Materials of the Earth; Minerals and Rocks; Weathering and Erosion. Plate tectonics; Volcanicity; Seismicity; Geological Time Scale.	10
II	**METEOROLOGY** Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiation laws, shortwave and long wave radiations, Albedo, Emissivity, Inversion; The boundary layer; Radiation balance of the Earth; Heating of Earth' surface and its atmosphere; Rotation of the Earth- Coriolis acceleration; Circulation of water and energy in atmosphere, El Nino, La Nina	20
III	**CLIMATOLOGY** Seasons and monsoons, Precipitation, Cloud classification and formation Local microclimate Weather and Climate in India, Climatic classification schemes, Climate change - Emissions and Global warming.	20
IV	**OCEANOGRAPHY** Sea water properties, Chemistry of seawater, Waves, Tides and Currents, Upwelling and El Nino, Marine Resources, Marine Pollution, Global Warming and Oceans - Greenhouse effect, Ocean warming, Sea level rise, Acidification, Carbon sequestration.	10

Suggested Books:

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.
7. Frank Press, Raymond Siever, John Grotzinger, *Understanding Earth*. Editors Thomas
8. H. Jordan, Tom Jordan W. H. Freeman & Co Ltd ISBN-10: 1464138745; ISBN-13: 978-1464138744

9. Frederick K. Lutgens Edward J. Tarbuck Pearson Education, *The Atmosphere An Introduction to Meteorology* Inc. ISBN-10 0-32-158733-2 ISBN-13 978-0-321-58733-6
10. Tom Garrison *Essentials of Oceanography* ISBN-13: 978-0-495-55531-5 ISBN-10: 0-495-55531-Brooks/Cole Cengage Learning 10 Davis Drive Belmont, CA 94002-3098 USA

SUGGESTED WEB SOURCES:

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

Programme/Class: MSc Environmental Science	Year: First	Semester: II
Course Code: MSC-EVS-201	Course Title: **Air and Noise: Pollution and Abatement**	

Course outcomes: After completing the course the student will be able to:

1. Understand the fundamentals of origin, impacts and control of different air pollutants.
2. CO2: Explain the types, nature and behavior of air pollutants under the influence of atmospheric conditions.
3. Appraise the monitoring techniques and control measures to curb the air pollution, considering the standards limits.
4. Understand the technical aspects of sound waves and controlling methods for vibration and noise pollution.

Credits: 4	**Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**AN INTRODUCTION TO AIR POLLUTION** Air Pollution: World and Indian scenario; Sources and classification of air pollutants; Criteria Air Pollutants and their properties; Atmospheric Aerosols; Long Range Transport of Atmospheric Pollutants; Impacts of air pollutants on health, plants and materials; The Air (Prevention and Control of Pollution) Act, 1981 and its amendments, National Air Quality Standards	10
II	**AIR POLLUTION MONITORING** Air pollutants sampling: Sedimentation, High-volume Filtration, Tape sampler, Impingement and Electrostatic precipitator; Collection of gaseous air pollutants: Grab sampling, Absorption in liquid, Adsorption on solids, Freeze out sampling; Indoor Air Monitoring. Source Sampling: Representative sampling, isokinetic sampling, Flue gas analyzer principles for monitoring COx, NOx, SOx, Hydrocarbon. Air Pollutants Dispersion and Modelling: Meteorological aspects of air pollutants dispersion, Plume behavior; Gaussian Plume Model, Line source model and Area source model.	15
III	**AIR POLLUTION CONTROL TECHNOLOGIES** Particulate pollutants Control: Gravitational Settling Chambers, Cyclonic separator, Fabric filter System, Electrostatic precipitators, Wet scrubbers Gaseous Pollutants Control: Absorption; spray chambers (and towers or columns), plate or tray towers, packed towers, and venturi scrubbers; Adsorption, Pressure-Swing Adsorption (PSA), Condensation: Surface and contact condensers; Combustion: Direct-flame, thermal and catalytic combustion Vehicular Pollution Control: Air-Fuel ratio, Catalytic convertor: Selective catalytic reduction (SCR), Selective non-catalytic reduction (SCNR), Bharat Stage Emission Standards (BSES)	20
IV	**NOISE POLLUTION** Definition; Sources; Decibel Scale, Sound Pressure Level, Combining Decibel,	15

	Frequency Weighting Networks, Noise Indices (L10, L50, L90, Leq, LDN, TNI). Noise & vibration measurement and noise standards, Noise control and abatement measures: Active and Passive methods, Impact of noise and vibrations on human health.	

Suggested Books:

1. Bell, L.H. and Bell, D.H., 1994. Industrial noise control: Fundamentals and applications.
2. New York.
3. Cheremisinoff, N.P., 2002. Handbook of air pollution prevention and control. Elsevier.
4. Clarke, A.G. ed., 2012. Industrial air pollution monitoring. Springer Science & Business Media.
5. Rao, C.S., 2007. Environmental pollution control engineering. New Age International.
6. Tiwary, A. and Williams, I., 2018. Air pollution: measurement, modelling and mitigation. CRC Press.
7. Vallero, D.A., 2014. Fundamentals of air pollution. Academic press.
8. Wang, L.K., Pereira, N.C. and Hung, Y.T. eds., 2005. Advanced air and noise pollution control. Totowa, NJ, USA: Humana Press.
9. Wark, K., Warner, C.F. and Wayne T, D., 1998. Air pollution: its origin and control. Addison-Wesley.

SUGGESTED WEB SOURCES:

1. https://swayam.gov.in/ https://nptel.ac.in/courses/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
4. http://moef.gov.in/
5. https://cpcb.nic.in/

Programme/Class: MSc Environmental Science	Year: First	Semester: II
Course Code: MSC-EVS-202	Course Title: **Water Pollution and Control Technologies**	

Course outcomes: After completing the course the student will be able to:

1. Acquire the knowledge of basic rationale of water quality management.
2. Characterize the typical inorganic and organic pollutants from a variety of sources entering into water bodies.
3. Design and develop water purification techniques for safe drinking water and wastewater treatment technologies for abatement of water pollution.
4. Apply the knowledge of various methods for water resource management.

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**DRINKING WATER CHARACTERISTICSAND PURIFICATION TECHNIQUES** Water Sources – Availability and quality of Surface water and Groundwater, Water Requirements for Domestic Consumption (Population forecasting), Drinking water standards (physical, chemical & bacteriological), Water Treatment process – Principal, process design and applications (Aeration, flocculation, Sedimentation, Filtration, Disinfections (Chlorination, UV, Ozonation), water softening.	15
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.	15
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. 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, aerated lagoon.	20
IV	**WATER RESOURCE MANAGEMENT** Eutrophication, Recovery of eutrophicated lakes, rehabilitation of polluted rivers-Ganga Action Plan, Yamuna Action Plan and new Plans introduced by Govt. of India.	10

Suggested Books:

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

SUGGESTED WEB SOURCES:

1. https://cpcb.nic.in/
2. https://www.epa.gov/environmental-topics
3. https://www.unced.int/issues/land-and-drought

Programme/Class: MSc Environmental Science	Year: **First**	Semester: **II**
Course Code: MSC-EVS-203	Course Title: **Solid Waste Handling and Management**	

Course outcomes: After completing the course the student will be able to:

1. Identify the hazardous and non-hazardous waste.
2. Learn the various hazardous waste management strategies.
3. Learn the various domestic waste management strategies.
4. Learn the various acts related to hazardous and domestic waste.

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**Hazardous Waste: Types, Status and Impacts** ▪ Types of hazardous wastes, characterization and listing ▪ Status of hazardous waste generation and disposal in India ▪ Environmental issues of hazardous waste disposal ▪ Impacts of hazardous waste on environment: Soil, groundwater and coastal environs ▪ Impacts of hazardous waste on wildlife and human health	10
II	**Hazardous Waste: Biomedical waste and Legislation** ▪ Biomedical waste Management ▪ Category of waste, segregation, collection and transportation. ▪ Treatment and Disposal system: Incinerator, Autoclave, Microwave, Training, Biomedical waste rules ▪ Worker safety in Handling Hazardous waste ▪ Legislation in India: Biomedical Wastes (Management and Handling) Rules, 1998 and amendments.	10
III	**Hazardous Waste Management** ▪ Hazardous waste Treatment, Storage and Disposal Facilities ▪ Hazardous waste processing: Secure landfill, Incineration and Recycling ▪ Hazardous waste determination and disposal site selection ▪ EIA and mitigation approaches for environmental impacts	10

	▪ Hazardous waste management in Gujarat	
IV	**Introduction to Solid Waste Handling and Management** ▪ Classification of Solid waste – source based and type based. ▪ Waste characteristics and Quantitative estimation of municipal solid waste. ▪ Waste Generation and Composition ▪ Factors affecting solid waste management ▪ Material Flow Methodology	10
V	**Processing of Urban Waste** ▪ Methods of collection, storage, transportation. ▪ Material Separation ▪ Processing on site and off site for source reduction, product recovery and recycling ▪ Methods of disposal – Dumping, Sanitary Landfill, Incineration, Pyrolysis, Composting, Ocean Dumping. ▪ Leachate Management for MSW landfills	10
VI	**Applied Uses of Solid Waste** ▪ Biogas production, Composting and Vermicomposting ▪ International cooperation in municipal solid waste management. ▪ Integrated Waste Management ▪ Municipal Solid Waste Management & Handling Rules,2000	10

Suggested Books:

1. Harry Freeman, Harry M. Freeman., Standard handbook of Hazardous waste treatment and disposal. Mc Graw Hill. (1998).
2. Porteous A. (1985) Hazardous waste management handbook. Bufferworths, London(U.K)
3. Harish K.(2001) Environmental Health Hazards. Sarup& Sons, New Delhi.
4. Wentz C. A.(1995) Hazardous Waste Management ,Mc. Graw – Hill Book Company, Koga
5. Ministry of Environment & Forest: Guidelines for Transport, Storage and Disposal of Hazardous Waste. New Delhi.
6. AareneVesilind .P, Worrell.W&Reinhart.D(2002),Solid Waste Engineering, Cengage Learning India Pvt. Ltd .
7. Cunningham, W. P. (2001): Environmental Science- Global Science. McGraw Hill, London.
8. Liu.H.F and Liptak.G.B.(2000),Environmental Engineer's Handbook, Second Edition, Lewis Publishers , New York
9. Peper, I. L., Gerba, C. P. &Brusseau, M. L.(1996): Pollution Science. Academic Press, San Diego.
10. Ramachandra.T.V (2006),Management of Municipal Solid Waste, Capital Publishing Company
11. Tchobanoglous G and Kreith. F(2002), Handbook of Solid Waste Management, Second Edition, McGraw- Hill Companies.
12. Tchobanoglous G, Rowe.R.D and Peavy. S.H (1985), Environmental Engineering, International Edition, McGraw –Hill Book Co. Singapore

Programme/Class: MSc Environmental Science	Year: First	Semester: II
Course Code: MSC-EVS-204	Course Title: **Environment, Health and Safety**	

Course outcomes: After completing the course the student will be able to:

1. Learn about the environmental toxicants, their sources, origin and effects of various toxic materials and heavy metals that impact the environment adversely.
2. Correlate the common work-related diseases and train on methods used to assess the risk involved at occupational settings.
3. Manage handling and storage of hazardous substances at work place.
4. Analyze health and safety problems in the working as well as living environment and recommendations safety measures.

Credits: 4 | **Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**INTRODUCTION** Basic Principle of Occupational Environment & Health and its implications. Environmental Health: - Environmental health criteria. Effects of Industrial pollutants like mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Water borne diseases; Prevention and protection of community health from water borne diseases. Indoor Air Quality of workplace and its effect on human health. Respiratory diseases associated with Industrial Environment. Effect of Noise on human health & it's preventive & control. Effects of Physical Environment on human health: Effects of temperature, humidity, ionization, thermal stress, altitude, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. Effect of workplace environment and weather on working efficiency and mental health. Effect of physiological response of man to different environmental stresses.	15
II	**OCCUPATION HAZARDS AND HAZARDOUS CHEMICAL** Occupation Hazards: - Occupational Environmental Hazards & its Types - Physical, chemical, biological, mechanical and psychosocial hazards, Occupational diseases, Ergonomics, Healthy workplace and its principles. Industrial hazard Analysis. Hazardous chemicals: Classification of hazardous chemicals, Material Safety Data Sheet, transportation of hazardous chemicals, hazchem code, Storage and handling of hazardous substances, Compatibility of different chemicals, Emergency preparedness (on site & offsite), Safety mock drills, Safety audit, Concept of fire and explosion, Major accidents involving hazardous substances and consequence analysis. Case studies for Industrial Accidents.	15
III	**HEALTH AND SAFETY MEASURES** Health and Safety Measures: - Medical and engineering measures, Stress at work and its management, Personal protection equipment and their significance, Work permit system and its necessity, Risk Assessment with numerical, Risk management: organization and administration; techniques and practices. Disaster Management Plan of Industry. Health Survey: Survey, analysis and recommendations regarding health and safety problems in the working and living environment. Biostatistics, epidemiology: Application of statistical methods to medical records in the study of health problems	15

	of human population in a given environment. First Aid & onsite medical facilities.	
IV	**LEGISLATION MEASURES** Occupational Health and Safety Standards, OHSAS-18001 / ISO 45001, The factory Act, 1948 and its amendments, Manufacturing, storage and import of hazardous chemical rules, 1989 and its amendments. The Chemical Accidents (Emergency Planning, Preparedness & Response) Rules 1996 / 2000, The Public Liability Insurance Act 1991 & amendments, Gas Cylinder Rules, 1984 and amendments, The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 and amendments etc.	15

Suggested Books:

1. Nicholas, P Cheremisinoff, Madelyn L Graffia (1995) Environmental and Health and Safety Management 1st edition, William Andrew.
2. Barry S. Levy, David H. Wegman, Sherry L. Baron, Rosemary K. Sokas (2017) Occupational and Environmental Health: Recognizing and Preventing Disease and Injury 7th Edition OUP USA.
3. Jain, R. K., Rao S.S., (2000) Industrial Safety, Health and Environment Management Systems 4th Edition Khanna Publishers.
4. Robert H. Friis (2018) Essentials of Environmental Health 3rd Edition Jones and Bartlett Publishers, Inc.
5. Herman Koren, Michael S. Bisesi (2017) Handbook of Environmental Health, Volume I Biological, Chemical, and Physical Agents of Environmentally Related Disease CRC Press.
6. Prashar A. and Bansal P. (2010) Industrial safety and Environment S K Kataria and Sons.
7. Phillip Carson and Clive Mumford (1994) Hazardous Chemicals Handbook ScienceDirect.
8. Phillip R. B. (1995) Environmental Hazards and human health Lewis Publishers
9. Fulekar M.H. (2006) Industrial Hygiene and Chemical Safety I K International Publishing House
10. Major Hazard Control: A Practical Manual - An I.L.O. Contribution to the International Programme on Chemical Safety of U.N.E.P., I.L.O., W.H.O(1988) International Labour Office
11. Gupta A K., (2021) Industrial Safety & Environment Laxmi Publications

SUGGESTED WEB SOURCES:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://swayam.gov.in/
3. https://nptel.ac.in/courses/

Programme/Class: MSc Environmental Science	Year: Second	Semester: III
Course Code: MSC-EVS-301	Course Title: **Sustainable Environmental Development and Disaster Management**	

Course outcomes: After completing the course the student will be able to:

1. Describe hazard, emergency, disaster, vulnerability, disaster management and risk,
2. Gain insight into different types of disasters/hazards, their implication on environment and to identify the main hazards to which our region is, or may be, vulnerable.
3. Differentiate, assess and apply the theoretical knowledge of disaster and emergency management activities and risk assessment to reduce the effects of disasters on vulnerable groups.
4. Critically analyze the influence of new emergent technologies on the disaster management.

Credits: 4 | **Compulsory**

Unit	Topic	No. of Lectures
I	**Sustainable Development** ▪ History of the concept of sustainable development, and the key principles ▪ Environmental degradation, poverty and sustainable development ▪ Environmental management and innovation strategies for sustainable development ▪ Governance for sustainable development . ▪ Policy responses to environmental degradation	10
II	**Implications of Environmental Management and WTO regime** ▪ WTO and formation of WTO ▪ Tools for Environmental Management. ▪ Trade and environment in the WTO regime. ▪ Measures taken by WTO in trade affairs and improving environment ▪ Environmental legislations, institutions and policies with special reference to India.	10
III	**INTRODUCTION TO DISASTERS** Introduction to Natural and Manmade Disasters; Floods, 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; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters.	10
IV	**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.	10
V	**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	10

	studies.	
VI	**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; Role of legislations in Disaster Management, Disaster Management Act 2005 and amendments, National Green Tribunal, Environment Protection Act, 1986, Explosive Substances Act, 1908, Atomic Energy Act, 1962, Local Administration and disaster risk reduction; Relief and Rehabilitation.	10

Suggested Books:

1. William H. D and Bruce R. M., Geology and Engineering, WCB Publishers, Iowa, 1986.
2. Sushmitha Bhaskar and R. Bhaskar, Natural Disasters, Unicorn Books, 2011.
3. Bell, F.G.2003, Geological Hazards, Their Assessment Avoidance and Mitigation, CRC Press
4. Smith, K. 2003, Environmental Hazards: Assessing Risk and Reducing Disasters. Routledge.
5. John M. Wallace and Peter V. Hobbs, Atmospheric Science: An Introductory Survey, Academic Press, New York, 1977.
6. Barbar W. Murk et. al., Environmental Geology, John Wiley & Sons, New York, 1996.
7. 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.
8. Collins Larry R. and Schneid Thomas D., Disaster Management and Preparedness, Taylor and Francis 2000
9. Goel S.L. and Kumar Ram, Disaster Management, Deep and Deep Publications, 2001
10. Kukal, S. S., Kingra, P. K. (2019). Introduction to Environmental and Disaster Management,
11. Kalyani Publishers.
12. Parasuraman S., India Disasters Report: Towards a Policy Initiatives, Oxford University Press, 2004.
13. Krishnamoorthy . B. (2008), Environmental Management, Prentice-Hall of India Pvt. Ltd.
14. Chautervedi .P.(2003), Energy, Environment and Sustainable Development, Concept Publishing Company, New Delhi
15. Murthy. R.K.(2004), Disaster Management, Dominant Publishers and Distributors
16. Barrow.C.J (2005), Environment Management and Development,Roultedge New York
17. Kumar.H.D (2001),Sustainable Human Ecology, East-West Press Pvt.Ltd
18. Sahni.D. and Medury (2001),Disaster Mitigation, Experience and Reflection, Prentice- Hall of India, New Delhi

SUGGESTED WEB SOURCES:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://nptel.ac.in/courses/105/104/105104183/

Programme/Class: MSc Environmental Science	Year: Second	Semester: III
Course Code: MSC-EVS-302	Course Title: **Industrial Water and Wastewater Treatment**	

Course outcomes: After completing the course the student will be able to:

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

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**INDUSTRIAL WASTEWATER TREATMENT** Types of industrial wastewater pollutants, Industrial wastewater characterization, Classification of industries into green, orange and red, Standards of disposal for industrial wastes, MINAS, Industrial Estate planning. CETP: Requirement and objectives of CETP, Planning and management of CETP facilities for small-scale industries. General steps for the treatment of industrial wastewater: equalization, neutralization, sedimentation, oil separation, flotation, coagulation), Biological oxidation - removal of organics (sorption, stripping, biodegradation).	15
II	**WASTEWATER TREATMENT-I: PHYSICO-CHEMICAL METHODS** Nutrient removal – nitrification, denitrification, ANAMMOX, SHARON, CANON process; Biological phosphate removal (BPR); Fundamentals of Membrane processes; Types and classification of membranes; Advanced oxidation process and its application for wastewater treatment: Photocatalysis, ozonation	15
III	**WASTEWATER TREATMENT-II: BIO-BASED SYSTEMS** High Rate Technologies for industrial wastewater Treatment: Bioreactors for wastewater treatment - Membrane bioreactors (MBR), Moving Bed Biological Reactors (MBBR), Anaerobic Baffled Reactor (ABR) Energy recovery from wastewater; Natural systems for the management of Industrial wastewater: Constructed Wetland; Duckweed ponds; Reed Bed system; Waste stabilization ponds; Others; Sludge management. Zero liquid discharge concept in Industries.	15
IV	**WASTEWATER REUSE AND RESOURCE RECOVERY** Manufacturing process, Waste/emission generation sources, Waste characteristics, Effluent Treatment, reuse and recovery of resources from (1) Textile Industries (2) Distilleries (3) Sugar (4) Paper and Pulp mills (5) Tanneries (6) Food Processing industries (7) Fertilizer Industry (8) Mining industries. (9) Petroleum industries	15

Suggested Books:

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, Industrial 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. G, Burton, F. L., Stensel H. D. (2002). Wastewater engineering: treatment and reuse, McGraw-Hill Science, USA.

SUGGESTED WEB SOURCES:

1. https://swayam.gov.in/
2. https://nptel.ac.in/courses/
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

Programme/Class: MSc Environmental Science	Year: **Second**	Semester: **III**
Course Code: MSC-EVS-303	Course Title: **Environmental Management Systems, Environmental, Impact Assessment and Environmental Audit**	

Course outcomes: After completing the course the student will be able to:

1. Lay foundation on the concept and components of environmental impact assessment.
2. Develop the skill to write and design the draft of EIA report.
3. Understand and identify the key aspects of environmental audit
4. Understand how to write EIA report and risk analysis

Credits: 4	**Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**Implementation of Environmental Management System** ▪ EMS definition ,Environment Policy and components of EMS ▪ Identification of environmental aspects and impacts. ▪ Legal and other requirements ▪ Training and awareness requirements ▪ Application of Environmental Standards- ISO standards and history of their development	10
II	**Environmental Audit** ▪ Basics of Environmental Audit and its need. ▪ Types of Environmental Audits ▪ Environmental Appraisal and Environmental Accounting ▪ Environmental Audit Procedure	10

	▪ Case studies	
III	**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. Sources and collection of data for EIA, various appendices and forms for application.	10
IV	**EIA METHODOLOGY** Components of EIA, EIA methodology – project screening, scoping, base line data, impact identification, prediction, evaluation, mitigation. methods of prediction matrices, networks, checklists and overlays and assessment of impacts – air, water, soil, noise, biological, social, cultural, economic, environmental factors, cost benefit analysis. EIA standards and guidelines, public participation- procedure of public hearing, presentation, review and decision-making expert system in EIA, Documentation and monitoring – Generic structure of EIA Document, planning, collection, use of display materials, team writing, checklist, environmental monitoring guidelines and policies, post audit.	10
V	**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, Legal requirements for environmental auditing.	10
VI	**CASE STUDIES OF EIA AND RISK ANALYSIS** EIA Case study – Environmental impacts of mining industry; nuclear power plant; textile industry; petroleum refining; fertilizer industry; EIA of Hydroelectric dam and river valley projects; thermal power plants. Risk assessment in EIA- Basic steps in risk assessment, hazard identification, Exposure assessment, Dose-response assessment, risk characterization.	10

Suggested Books:

1. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York
2. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co., New Delhi. 2006.
3. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.
4. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006.
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.

SUGGESTED WEB SOURCES:

1. https://swayam.gov.in/
2. https://nptel.ac.in/courses/
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
4. http://moef.gov.in/en/#

Programme/Class: MSc Environmental Science	Year: **Second**	Semester: **III**
Course Code: MSC-EVS-304	Course Title: **Environmental Laws**	

Course outcomes: After completing the course the student will be able to:

1. Become aware about the rights of nature and natural resources.
2. To understand the various environmental laws, thereby become aware about environmental protection.

Credits: 4	**Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	Scheme of lebelling of environmentally friendly products (ecomark). Public liability Insurance Act. 1991. Provision of constitution of India regarding environment (article 48 A & 58A).	15
II	Environmental policy resolution, legislation, public policy strategies in pollution control. Wild life protection act, 1972 amended 2002. Forest conservation act, 1980. Indian forest act 1927.	15
III	Air (prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. Motor vehicle act, 1988, The environment (protection) Act, 1986, rules 1986.	15
IV	The water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975. Environment protection issues & problems, international & national efforts for environment protection.	15

Suggested Books:

1. Environmental administration & law - Paras Diwaa.
2. Environmental planning, policies & programs in India - K.D. Saxena.

Programme/Class: MSc Environmental Science	Year: **Second**	Semester: **III**
Course Code: MSC-EVS-305	Course Title: **Soil and Solid Waste Management**	

The Course aims

1. • To understand the soil system and its importance
2. • To know about solid waste generation, treatment and disposal
3. • To get knowledge to characterize hazardous wastes
4. • To know the safe disposal of hazardous wastes
5. • To study the various acts related to waste management

Credits: 4 | **Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Unit	Topic	No. of Lectures
I	Nature of the soil- water and air in the soil- soil reactions and ion exchange in the soil, macro and micronutrients in the soil. Soil pollution- sources- agricultural chemicals, fertilizers, pesticides, insecticides, fungicides, herbicides, industrial wastes and metals - soil erosion	12
II	Municipal solid wastes – Quantities and characteristics, waste collection and transports, waste processing and resource recovery and recycling, incineration, pyrolysis, composting vermicomposting and sanitary landfills, anaerobic digestion. Municipal solid waste latest regulations.	12
III	Hazardous wastes-classification and characterization of hazardous wastes-industrial hazardous wastes and e-waste. Storage and transportation of hazardous wastes. Recycling technology for hazardous wastes. Physical, chemical and biological fixation/stabilization of hazardous wastes. Criteria for hazardous wastes landfill site.	12
IV	Environmental Protection Act (1986) - The Manufacture, Storage and Import of Hazardous Chemical Rules (1989) - The Rules for the Manufacture, Use, Import, Export and Storage of Hazardous micro-organisms. Genetically engineered organisms/ cells (1989) - Fly ash in construction activities - Dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land notifications (1999) - The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules (1996) - The Batteries (Management and Handling) Rules (2001).	12
V	Classification of biomedical wastes and treatment methods ,The Biomedical Waste (Management and Handling) Rules (1998), The Plastics (Manufacture, Usage and Waste Management) Rules (2009), Recycled Plastics Manufacture and Usage Rules (1999). E-waste (Management and Handling) Rules (2011).	12

Reference Books:

1. The text Book of Soil Science -Dhaji, Media Promoters and Publishers Pvt. Limited, 1996
2. The Nature and properties of soil -Harry O. Buckman, Macmillan, 1922
3. Soil physics -Helmut Kohuke, McGraw-Hill, 01-Jan-1968
4. Soil Pollution and soil organisms - PC Mishra, APH Publishing Corporation.
5. Environmental Agricultural pollution- P.R. Trivedi, New Delhi: Akashdeep Publishing House, 1992.
6. Soil Chemistry and its application -Malcom Cresser, Cambridge University Press, 06-May-1993
7. Basic Environmental Technology -Nathensan, John Wiley, 1986.

Programme/Class: MSc Environmental Science	Year: Second	Semester: III
Course Code: MSC-EVS-306	Course Title: **Environmental Issues and Legislation**	

Course outcomes: After completing the course the student will be able to:

1. Understand initiatives taken at national and international level to protect and conserve environment.
2. Know rules and regulations applicable to industries and other organizations with significant environmental aspects.
3. Apply the legislations to control pollution and for solving the local environmental problems.
4. Prepare the management plan to protect environment.

Credits: 4 | **Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS** Environment protection: Issues and Problems; International and National efforts for Environment Protection; General Principles in Environmental Law: Precautionary Principle; Polluter Pays Principle; Sustainable Development, Constitutional provisions of Constitution of India regarding Environment (Article 48A, 51A (g) and 253).	15
II	**NATIONAL & GLOBAL ENVIRONMENTAL INITIATIVES** International Initiatives towards Environmental Protection: Stockholm Conference, Earth Summit, World Summit on Sustainable Development, Rio+20, Ramsar Convention, Vienna Convention, Montreal Protocol, Kyoto Protocol; Sustainable Development Goals; Ecomark Scheme	15
III	**ENVIRONMENTAL LAWS & LEGISLATIONS** The Water (Preventions and Control of Pollution) Act, 1974; National Water Policy, 2002; Air (Prevention and Control of Pollution) Act, 1981; Environmental (Protection) Act, 1986; National Environmental Policy, 2006; Motor Vehicle Act, 1988 (Environmental Aspects only); Public Liability Insurance Act, 1991; Coastal Regulation Zone (CRZ) Notification, 1991; Noise Pollution (Regulation and Control) Rules, 2000	15
IV	**LEGISLATION RELATED TO BIODIVERSITY** National Forest Policy, 1988; Wildlife Protection Act, 1972 and Amendments; Forest Conservation Act, 1980; Indian Forest Act, Revised 1982; Biological Diversity Act, 2002	10

Suggested Books:

Divan S. and Rosencranz A. (2015). Environmental Law and Policy in India. Oxford, New Delhi

1. Dwivedi, S. K., & Kashyap, P. (2013). Environmental Protection Law and Policy in India.
2. Ghosh, S. (Ed.). (2019). Indian Environmental Law: Key Concepts and Principles. Orient BlackSwan.
3. Leelakrishnan, P. (2016). Environmental law in India. LexisNexis.
4. Nath B., Hens, L., Compton, P. and Devuyst, D. (2018). Environmental Management in Practice, Vol I, Routledge, London and New York.
5. Singh, G. (2017). Environmental law in India. Mc Millan, New Delhi.
6. Upadhyay S. and Upadhyay V. (2017). Hand Book on Environmental Law- Forest Laws, Wildlife Laws and the Environment; Vols. I, II and III, Lexis Nexis- Butterworths-India, New

Programme/Class: MSc Environmental Science	Year: Second	Semester: III
Course Code: MSC-EVS-307	Course Title: **Entrepreneurship**	

Course outcomes: After completing the course the student will be able to:

1. Understand the basic concepts of entrepreneur, entrepreneurship and its importance.
2. Aware of the issues, challenges and opportunities in entrepreneurship.
3. Develop capabilities of establishing environmental testing laboratories.
4. Know the availability of various institutional supports for making a new start-up.

Credits: 4 | **Compulsory**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	Introduction to entrepreneur and entrepreneurship: Characteristics of an entrepreneur; Characteristics of entrepreneurship; entrepreneurial traits and skills; innovation and entrepreneurship; Types of entrepreneurial ventures; enterprise and society in Indian context; Importance of women entrepreneurship, Case Studies-Success stories.	15
II	Promotion of a venture – Why to start a small business; How to start a small business; opportunity analysis, external environmental analysis, legal requirements for establishing a new unit, raising of funds, and establishing the venture - Project report preparation format for a preliminary project report, format for a detailed/final project report. Case Studies.	15
III	Establishment of environmental testing laboratory: Infrastructural requirements, Legal provisions of recognition laboratories, Accreditation of environmental laboratories, procedure of NABL accreditation, procedure for recognition from State and central Government agency, certification procedure (ISO 14001), Guidelines for recognition of laboratory under the Environment (Protection) Act, 1986.	15
IV	Establishment of environmental consultancy: Different type of consultancy, Environmental impact assessment, recognition of a EIA consultant organizations, QC/NABET regulations for accreditation of consultancy (ISO 9001).	15

Suggested Books:

1. Desai, Vasant (2019). Management of a Small-Scale Industry, Himalaya Publishing House.
2. Chandra, Prasaaan (2018). Project Preparation, Appraisal, Implementation, Tata Mc- Graw Hills.
3. Jain, P. C. (2015). Handbook of New Entrepreneurs, Oxford University Press.
4. srivastava, S. B. (2009). A Practical Guide to Industrial Entrepreneurs, Sultan Chand & Sons.
5. Arora, Renu (2008). Entrepreneurship and Small Business, Dhanpat Rai & Sons Publications.

SUGGESTED WEB SOURCES:

1. **https://nptel.ac.in/courses/110/106/110106141/**
2. **https://startupsusa.org/**

Programme/Class: MSc Environmental Science	Year: Second	Semester: III
Course Code: MSC-EVS-308	Course Title: **Environmental Awareness, Policies and Laws**	

Course outcomes: After completing the course the student will be able to:

1. Understand environmental legislation and policies of national and international regime.
2. Know regulations applicable to industries and other organizations with significant environmental aspects.
3. Apply the legislation concepts for solving the local environmental problems.
4. Get knowledge of the legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance.

Credits: 4	Compulsory

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	**ENVIRONMENTAL AWARENESS** Introduction to Environment and Pollution, Current environmental issues (climate change, biodiversity, ozone layer depletion), Role of media in environmental awareness, Role of NGOs, public participation in environmental movements; Stockholm Convention, Earth Summit, Vienna convention & Montreal Protocol, UNFCCC & Kyoto Protocol, Swachh Bharat Abhiyan, Ganga Action Plan, Yamuna Action Plan.	15
II	**ENVIRONMENTAL POLICIES AND LAW-I** Provision of Constitution of India regarding Environmental protection [Article 48A and 51-A (g)], Introduction, salient features, latest amendments and drawbacks of the following acts: Water (Prevention and Control of Pollution) Act, 1974; Water Cess Act, 1977; Air (Prevention and Control of Pollution) Act, 1981; Environmental (Protection) Act, 1986; Wild Life (Protection) Act 1972; Forest (Conservation) Act, 1980; Motor Vehicle Act, 1988 (environmental aspects); Public Liability Insurance Act, 1991.	15
III	**ENVIRONMENTAL POLICIES AND LAW-II** National Green Tribunal Act, 2010; Disaster Management Act, 2005; Solid Waste Management Rules, 2016; Plastic Waste Management Rules, 2016; E-Waste Management Rules, 2016; BioMedical Waste Management Rules, 2016; Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; Construction and Demolition Waste Management Rules, 2016, Notification of Ash utilization 1999, 2003, 2009, 2015 and amendments if any.	15
IV	**ENVIRONMENTAL MANAGEMENT SYSTEM AND AUDIT** Principles, scope and elements for successful environmental management, ISO 14000 Series, Eco-mark Scheme, Preparing environmental management system for an organization, EIA and environmental audit; EIA notification, 2006 and amendments thereof.	15

Suggested Books:

1. Environmental Planning, Policies & Programmes in India – K.D. Saxena.
2. Environmental Administration and Law- Paras Diwan
3. Suresh Jain and Vimla Jain, Environmental Laws in India, The Lawyers home, Indore.
4. Don Sayre, Inside ISO 14000, Deep & Deep Publications (1997)

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme		Subject Total
				L	P	T	Total		Dissertation	Viva-Voice and Presentation	
Semester IV	M.Sc.-EVS-451	Project	Core Course	0	20	0	20	20	400	100	500
	M.Sc.-EVS-452	Seminar	Qualifying	0	1	0	1	1	0	100	100
			Total	0	20	0	20	21	500	100	600