P.G. DEPARTMENT OF ENVIRONMENTAL SCIENCE

RANCHI UNIVERSITY, RANCHI

Syllabus for M.Sc. Environmental Science
Based on CBCS system
from the Academic session 2020-2022 onwards.

M.Sc. Environmental Science
Syllabus based on CBCS semester system

ELIGIBILITY REQUIREMENTS

B.Sc. in any basic science subjects such as Zoology/ Botany/ Physics/ Chemistry/ Life Sciences/ Geology/ Agricultural Science/ Environmental Science/ Ecology/ Biological Science/ Natural Resource Management/ Water Resource Management /B. Tech. with a minimum of 55 % marks for General/OBC candidates and 50% marks for SC/ST candidates from any recognized University.

OBJETIVE OF THE PROGRRAMME

The two-year (four semesters) Postgraduate Programme is designed to provide necessary knowledge and skills to postgraduate students, so that they can learn to analyze and asses environmental systems and problems; to enable the students to propose sustainable solutions and contribute to the development of policies and strategies for environmental planning. The major thrusts of the Programme are:

1. To study natural resources, the impacts of human activities thereon and the implications of environmental degradation on human development.
2. Natural Processes in the Environment, which focus on the natural processes such as the Atmospheric, Biogeochemical, Ecological and Hydrological processes
3. The Human Dimension of Environmental Change: to understand the determinants of the growth of populations and economies, and how this growth results in demand for natural resources, leading to scarcity, pollution and risks for human health
4. Analytical Tools in Environmental Science: basic tools for analyzing environmental issues, such as data collection and analysis and modelling of air, water, soil and biological systems.

M. Sc in Environmental Science will have total 80 Credits & total marks of 1600.

Table: Semester wise Examination Structure for Mid Sem & End Sem Examinations:

Semester	Paper No	Course Code	Course Tittle	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	PAPER I	EVS- 101	Basic Ecology	30	70	---
	PAPER II	EVS- 102	Earth & Atmospheric Science	30	70	---
	PAPER III	EVS- 103	Natural Resources & Sustainable Development	30	70	---
	PAPER V	EVS- 104	Practical's based courses	---	---	100
II	PAPER V	EVS- 201	Biodiversity & Conservation	30	70	---
	PAPER VI	EVS- 202	Environmental Pollution & Toxicology	30	70	---
	PAPER VII	EVS- 203	Waste Treatment and Management	30	70	---
	PAPER VIII	EVS- 204	Practical's Based Courses	---	---	100
III	PAPER IX	EVS- 301	Global Environmental Changes and EIA	30	70	---
	PAPER X	EVS- 302	Remote Sensing, GIS and Environmetrics	30	70	---
	PAPER XI	EVS- 303	Disaster Management and Environmental Economics	30	70	---
	PAPER XII	EVS- 304	Practical's Based Courses	---	---	100
IV	PAPER XIII	EVS- 401	Environmental Law, Tools & Techniques and Research Methodology	30	70	---
	PAPER XIV	EVS- 402	EVS- 402(Optional -I): Environmental Biotechnology and Clean Technology	30	70	---
			EVS- 402(Optional -II): Water Resource Conservation& Management	30	70	---
			EVS- 402(Optional -III): Environmental Education	30	70	---
	PAPER XV	EVS- 403	Dissertation & Project	---	---	100
	PAPER XVI	EVS- 404	Practical's Based Courses	---	---	100

M.Sc. in Environmental Science will have total 16 Papers & total marks of 1600.

SEMESTER - I

4 Papers **Total 100 x 4 = 400 Marks**

EVS- 101: Basic Ecology

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Organisms and Environment

- Holocoenotic nature of environment
- Environmental variables Temperature, Light, Water
- Morphological and physiological responses of organisms to environmental variables
- Edaphic factors- and soil enzymes
- Interaction of factors, Liebig's law of minimum & Shelford's law of tolerance

Unit II - Population ecology

- Population characteristics
- Population growth, carrying capacity, life table
- Population regulation-density independent and dependent, Life history strategies (*r* and K selection)
- Population interactions, Lotka – Volterra model, Population differentiation

Unit III - Community ecology

- Concepts of community and continuum; community analytical and synthetic attributes; Species diversity indices (α, β and γ)
- Concept of ecological niche, niche compression and release, Niche overlap
- Community development: Models and mechanisms of ecological succession; Changes in ecosystem properties during succession; Concept of climax.

Unit IV - Ecosystem

- Ecosystem structure and functions
- Primary production (methods of measurement, global pattern, affecting factors)
- Energy Flow (Energy flow pathways Trophic organization, Lindeman's Trophic dynamic models, Ecological efficiencies, and models)
- Litter fall and decomposition; Biogeochemical cycles Carbon, Nitrogen, Sulphur & Phosphorus cycle

Suggested Readings:

- E.P. Odum and G.W. Barrett. 2005. Fundamentals of Ecology. Cengage Learning India Pvt. Ltd.
- J.S. Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment & Resource Conservation. Anamaya Publications.
- Dash M C & Das S P, Fundamental of Ecology, Mcgraw Hill Education (India) Pvt Ltd
- Living in the Environment: An Introduction to environmental Science, Miller GP, International Function publication

EVS- 102: Earth and Atmospheric Science

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Environmental Geology

- Origin of Earth, Evolution of earth's atmosphere & Biosphere
- Stratification & Composition of Biosphere
- Gaia Hypothesis

Unit II - Basics of Lithosphere

- Weathering and erosion processes
- Types and formation of soils and soil profile
- Major rock and ore forming minerals: Properties of minerals
- Igneous, sedimentary and metamorphic rocks

Unit III - Basics of Hydrosphere

- Hydrosphere & Its Types
- Groundwater: Occurrence
- Salt water intrusion
- Earthquakes, Volcanoes, Landslides and Floods: and their impact on environment

Unit IV - Basics of Atmosphere

- Stratification of atmosphere, Atmosphere and the earth's radiation balance, circulation of atmosphere, atmospheric stability, lapse rates and mixing heights, plume behavior; Gaussian plume model
- Photochemistry of nitrogen oxides, oxygen, ozone and chlorides in the atmosphere, Wind Rose Diagram
- General relationship between landscape, biomes and climate

Suggested Readings:

- T. R. Oke. 2006. Boundary layer climates. Methuen & Co. Ltd.
- S. Pal Arya. 2001. Introduction to Micrometeorology. Academic Press.
- H. R. Byers. 2006. General Meteorology. McGraw-Hill.
- K. S. Valdiya. 1987. Environmental Geology. Tata McGraw-Hill.
- J. M. Wallace and P. V. Hobbs. 2006. Atmospheric Science – An introductory survey Academic Press.
- Hamblin. (8th Ed). 2000. Earths Dynamic Systems. Prentice Hall.
- David Huddart and TimStott. 2010. Earth Environments- Past, Present and Future. Wiley-Blackwell.
- Environmental Geology, Coates 1981. Coates, John Wielly & Sons Publications
- Environmental Geology, Keller, Ce maririe Publication, Toranto Tata macgrowhill Publication, New Delhi.

EVS- 103: Natural Resource & Sustainable Development

Time- 3.00 hours **Full Marks -70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Natural Resources

- Natural Resources: Depletion and regeneration of natural resources, Renewable and non-renewable resources, Conservation strategy
- Biotic Resources- Forests, agriculture, fisheries, livestock, biodiversity and its conservation
- Abiotic Resources- Water resource, non-energy mineral resources, land resources

Unit II - Energy Resources

- Fossil Fuels: Oil, coal, natural gas, shale, tar sands – Sources, exploration, exploitation; environmental consequences
- Renewable and Alternative Energy Sources: Solar energy, solar power, photovoltaic cells; Wind power; Geothermal energy; Ocean energy; Fuel cells
- Bio Energy: Biomass conversion processes; Biodiesel; Environmental consequences of biomass resource harnessing
- Energy Conservation: National energy policy, energy efficiency improvement, audit and energy saving

Unit III - Nuclear Energy

- Nuclear fission and Fusion
- Nuclear fuel cycle
- Nuclear reactors (PWR, BWR, Gas Cooled Breeder)
- Nuclear power

Unit IV - Sustainable Development

- Concept of sustainable development
- Components of sustainable development
- Sustainability indicators

Suggested Readings:

- M. Dayal. (6th Ed). 1997. Renewable Energy: Environment and Development. Konark Pub. Pvt. Ltd.
- S. Vandana. 2002. Alternative Energy. APH Publishing Corporation.
- S. K. Agarwal. 2003. Nuclear Energy: Principles Practice and Prospects. APH Publishing Corporation.
- P. Chaturvedi. 1995. Bio-Energy Resources. Concept Publications.
- V S. Mahajan. 1991. National Energy: policy, crisis and growth. Ashish Publishing House.
- Ramade F Ecology of Natural Resources, John wiely & Sons, New York.
- Desai A V ed 2001, Non-Conventional Energy New Age International (P) Ltd UN University, Tokyo

EVS- 104: Practical's Based Courses

F.M.: 100

1. Introduction Species Diversity Calculations: various methods, Calculations of Density, Frequency, Abundance, Relative Density, relative Frequency & Relative abundance, Relative Importance Value Index
2. Biodiversity Calculations and interpretation Shannon Indices (Alpha Diversity, Beta Diversity & Gamma Diversity)
3. Water analysis- Dissolved oxygen, Free carbon dioxide, Carbonate, Bicarbonate and Hydro-oxide, Hardness, Chloride
4. Productivity Calculations: Aquatic & Terrestrial Plants
5. Visiting to near biodiversity & Eco restoration sites.
6. Case studies reports & Viva

SEMESTER - II

4 Papers **Total 100 x 4 = 400 Marks**

EVS- 201: Biodiversity & Conservation

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Introduction to biodiversity: species, genetic, species and habitat level of diversity
- Causes of biodiversity depletion, Biodiversity magnitude and distribution: diversity gradients and related hypotheses
- Mega-biodiversity zones
- Concept of conservation Wildlife special concern

Unit II

- Threats to biodiversity: Natural and anthropogenic
- Species extinctions
- IUCN threat categories
- Red data book, Invasions: causes and impact

UNIT III

- Biodiversity conservation, principles and strategies; *in-situ* and *ex-situ* conservation Protected Area Network. & Animal Conservation Corridors
- Biodiversity Hot spots: concepts, distribution and importance

UNIT IV

- Use of biodiversity: Source of food, medicine, raw material, aesthetic and cultural.
- Biodiversity planning & conservation with consideration of regional aspects

Suggested Readings:

- Anne E. Magurran. 2003. Ecological diversity and its measurements. Blackwell Publications.
- J.S.Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi).
- V.H. Heywood and Watson R.T. (Ed). 1995. Global Biodiversity Assessment: UNEP. Cambridge University Press

EVS- 202: Environmental Pollution & Toxicology

Time- 3.00 hours **Full Marks -70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Air Pollution

- Air pollution: Types and sources, Effects of various gaseous pollutants
- Classical & Photochemical smog, Acid Rain, Ozone layer depletion: Causes and consequences

Unit II - Water and Noise Pollution

- Noise pollution: Types, sources and effects on human health
- Water Pollution: Types and sources; Effects of water pollution on plants, animals and human health
- Thermal pollution

Unit III - Soil Pollution

- Soil pollution: Types and sources
- Effects of pesticides, fertilizers and heavy metals on ecosystems
- Mechanisms of metal toxicity, metallophytes
- Radioactive pollution: Sources and hazards.

UNIT IV - Toxicology

- Toxicology: Principles of toxicology, factors effecting toxicity: host, age, species & Strain, Sex, Food & Feeding, dose and duration response relationships, Chronic and acute toxicity
- Effective concentration, LD50, Median tolerance limit and Margin of safety;
- Toxicity testing (Holistic and Numeric approach). Toxico-kinetics, Toxico-dynamics and bioavailability
- Uptake, bioaccumulation, bio-transformation, Translocation and excretion of xenobiotics.

Suggested Readings:

- A. K. De. (3rd Ed). 2008 Environmental Chemistry. New Age Publications India Ltd.
- I. C. Shaw and J. Chadwick. 1997. Principles of Environmental Toxicology. Taylor& Francis Ltd.
- S.C. Santra. 2011. Environmental Science. New Central Book Agency.
- Ira. S. Richards. 2008. Principles and Practices of Toxicology in Public Health. Jones and Barlett Publications.
- Gupta P Toxicology Vol II & III, Meteropolitian Book Co.

EVS- 203: Waste Treatment and Management

Time- 3.00 hours **Full Marks -70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Solid Wastes and their management**:** Types of wastes – Municipal and industrial wastes, domestic waste; sewage and sludge; agricultural waste
- Solid waste characterization: ultimate and proximate analysis
- Integrated Solid waste Management; Waste reduction at source, volume reduction
- Collection techniques/ Methods and Transport of solid waste

Unit II

- Recycling, various treatments, treatment and disposal techniques
- Landfill -landfilling methods and operation. Leachate and Landfill gas, Leachate management
- Composting, Vermi-composting, biofertilizers
- Energy from Waste- Incineration, Pyrolysis, Gasification, Refuse derived fuels, Biogas.

Unit III

- Wastes from Industries- Petrochemical industries, Oil Refineries, textile, sugar, pulp and paper, cement, distilleries, dairy, food processing, mining.
- Collection, segregation, transport, treatment and disposal of effluents.
- Standards for disposal of treated effluents; Common Effluent Treatment Plants (CETP). Re-cycling and re-use of treated effluents-technologies.
- Concept of zero discharge. Waterborne diseases.

Unit IV

- Biomedical Wastes and their Management**:** Types of solids, liquids, sharps, blood and blood tissue, nuclear medicinal wastes
- Segregation and designated storage of biomedical wastes.
- Transport of medical waste: Authorization and accidental spilling reporting
- Biomedical waste treatment and disposal methods: Incineration.

Suggested Readings:

- Acharya, D.B. and Singh, M. Hospital Waste Management. Minerva Press, Delhi. 2003.
- Alleman, J. E. and Karanagh, J. T. Industrial Waste. Ann Arbor Science.1982.
- Bhatia, S.C. Solid and Hazardous Waste Management. Atlantic Publishers.2007.
- Blackman, W.C. Basic Hazardous Waste Management. CRC Press, USA. 2001.
- Evans, G. Biowaste and Biological Waste Treatment. James and James (Science Publishers) Ltd, U.K. 2005.
- Hasan Syed E. Geology and Hazardous Waste Management, Prentice Hall, USA, 1996.
- Kreith, F. Handbook of Solid Waste Management. McGraw Hill Publishers, USA. 22,1999
- LaGrega M.D., Buckingham, P.L. and Evans J.C., Hazardous Waste Management, McGraw Hill International Publications, Singapore, 1994 – Revised Edition Available – ISBN 0-07-113454-9.
- Moore, J. W. The changing Environment. Springer-Verlag. 1986.
- Pichtel, J. Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press, USA. 2005.
- Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999.
- Sloan, William M., (Ed). Site Selection for New Hazardous Waste Management Facilities, WHO Regional Publications, European Series 46, 1993.
- Tchobanogloas, G. Integrated Solid Waste Management: Engineering, Principle and Management. McGraw Hill, USA. 1993.
- Vesilind, P. A., Worrell, W. and Reinhart, D. Solid Waste Engineering**.** Brooks/Cole Thomson Learning Inc., USA. 2002.
- Williams, P.T. Waste Treatment and Disposal. John Wiley and Sons, USA. 2005

EVS- 204: Practical's Based Courses

F.M.: 100

1. Water quality analysis- analysis of different physic-chemical parameters
2. Study of Plankton and benthos
3. Quadrant analysis of vegetation, species area curve, determination of sampling size
4. Calculation of $LC_{50,}$ LD_{50}
5. Class Record
6. Viva voce

SEMESTER - III

4 Papers **Total 100 x 4 = 400 Marks**

EVS-301: Global Environmental Changes and EIA

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Atmospheric change

- Stratospheric ozone layer: Evolution of Causes ozone layer
- Causes of depletion and consequences
- Effects of enhanced UV-B on plants, microbes, animals, human health and materials

Unit II - Climate change and Global effort

- Climate change: Greenhouse effects; Drivers of climate change; Greenhouse gases and their sources
- Implications on climate, oceans, agriculture, natural vegetation, wildlife and humans
- Effects of increased CO2 on abiotic and biotic components
- International efforts on climate change issues. Atmospheric deposition: Past and present scenario, comparison with previous global warming

Unit III - Consequences of Pollution

- Eutrophication
- Acid rain and its effect on plants, animals, microbes and ecosystems
- Biological action spectra
- Global efforts for mitigation ozone layer depletion

Unit IV - EIA

- Concepts and Definitions and Historical Development of Environmental Impact Assessment (EIA)
- Scope and methodologies of EIA
- Baseline data collection, Environmental Impact Statement and Environment Management Plan
- EIA Regulations in India and current issues pertaining to EIA in India
- Environmental Appraisal, Environmental Audit and Green Audit

Suggested Readings:

- N. Adger, K. Brown, D. Conway. (Vol. 22). 2012. Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.
- Karl K. Turekian. 1996. Global Environmental Change-Past, Present, and Future. Prentice-Hall.
- Richard Anthony Matthew. 2009. Jon Barnett, Bryan McDonald. Global Environmental Change and Human Security. MIT Press., USA.
- Hester, R.E. and Harrison, R.M. 2002. Global Environmental Change. Royal Society of Chemistry.
- Barrow, C.J 2000, Social Impact Assessment, Oxford University Press
- Glasson J Therivel, R Chadwick A. 1994, Introduction to Environmental Impact Assessment, London Research Press, UK
- Judith P. 1999, Handbook for environmental Impact Assessment, Blackwell Science
- Marriot B, 1997, Environmental Impact Assessment: A practical Guide, Mcgraw-Hill, New York, USA

EVS- 302: Remote Sensing, GIS and Environmetrics

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Remote Sensing

- Fundamentals of Remote Sensing: Principles of remote sensing (Optical/Microwave), History of remote sensing
- Principles of Aerial photography
- Satellites, sensors, data generation
- Hyper spectral remote sensing

Unit II - Applications of Remote Sensing

- Image Interpretation: Principles of image interpretation
- Visual image interpretation
- Digital image processing- Image enhancement, image rectification, image classification techniques
- Accuracy assessment

Unit III - GIS and GPS

- Applications of remote sensing: Remote sensing-based land use/land cover mapping, urban landscape mapping, industrial land use
- GIS and GPS system: GIS concepts. Basic concepts of cartography
- Remote sensing of vegetation-spectral characters of vegetation, landscape ecology, remote sensing of vegetation change, remote sensing for biodiversity applications
- Remote sensing for soil studies, remote sensing for flood mapping, flood damage assessment, drought assessment, desertification and water shed management

Unit IV – Environmetrics

- Data processing, fundamentals of application of computer,
- Use of statistical tools like Standard deviation, Significance test using different tools, 2/2 contingency
- Correlation, Regression
- Difference in F-test and one-way ANOVA and F-test and two-way ANOVA
- Probability - Normal, Poisson and Binomial

Suggested Readings:

- George Joseph, Fundamentals of remote sensing, Universities press (India) Pvt Ltd., Hyderabad, 2003
- Jenson, J.R. Introductory Digital Image Processing: Prentice Hall Series, 1996.
- Jensen, J.R., Remote Sensing of the Environment – An Earth Resources Perspectiv, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.
- Lillesand, Thomas M. and Kiefer, Ralph, W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 2000.
- Michael N. Demers. Fundamentals of Geographical Information Systems. John Wiley & Sons, Inc. 2008. 20

EVS -303: Disaster Management and Environmental Economics

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Disaster- Types of Disaster- Natural & anthropogenic
- Causes and phases of disaster, Rapid onset and slow onset disasters. Nature and responses to geo-hazards
- Thunderstorms, Cloud bursting; meteorology and hydrology
- Changes in Coastal zone, coastal erosion, beach protection; Coastal erosion due to natural and man-made structures

Unit II

- Floods and Cyclones: causes of flooding, Hazards associated with flooding
- Flood forecasting. Flood management, Integrated Flood Management and Information System (IFMIS), Flood control
- Tsunamis – causes and physical characteristics

Unit III

- Earthquakes**:** Causes and characteristics of ground-motion, earthquake scales, magnitude and intensity, earthquake hazards and risks
- Volcanic land forms, eruptions, Landslides, rock-falls, avalanches
- Anthropogenic disaster & Its Management: Industrial disaster, Mining disasters

Unit IV

- Concept and definition of Environmental Economics
- Cost Benefit Analysis
- Carbon trading, Carbon foot print, Carbon credit, Carbon sequestration
- Application of sustainable goals
- CDM concept and its status in India
- Case Studies: Sardar Sarovar Dam Project, Narmada Dam Project, Silent Valley Project, Tehri Dam project.

Suggested Readings:

- Bolt, B.A. Earthquakes, W. H. Freeman and Company, New York. 1988
- Carter, N, W. Disaster Management: A Disaster Manager's Hand Book, Asian Development Bank, Manila. 1992
- Gautam Ashutosh. Earthquake: A Natural Disaster, Ashok Publishing House, New Delhi. 1994
- Sahni, P.and Malagola M. (Eds.). Disaster Risk Reduction in South Asia, Prentice-Hall of India, New Delhi. 2003.
- Sharma, V.K. (Ed.). Disaster Management, IIPA, New Delhi. 1995.
- Singh T. Disaster management Approaches and Strategies, Akansha Publishing House, New Delhi. 2006
- Sinha, D. K. Towards Basics of Natural Disaster Reduction, Research Book Centre, New Delhi. 2006
- Smith, K. Environmental Health, Assessing Risk and Reduction Disaster, 3rd Edition, Routledge, London. 2001 21

EVS- 304: Practical's Based Courses

F.M.: 100

1. Working Principles of different environmental monitoring Instruments.
2. Water Quality monitoring: Determination of water parameters: pH, Dissolved Oxygen, Total Solids, Total Suspended Solids, Total Dissolved Solids, BOD & COD, TOC.
3. Air Quality Monitoring as per NAAQS: Determination of PM 2.5 & PM 10, estimation of SOx, NOx, & CO, Ozone estimation.
4. Noise Pollution: noise level in Residential, Silent, Commercial, Industrial Areas
5. Project Work
6. Viva Voce

Semester - IV

4 Papers **Total 100 x 4 = 400 Marks**

EVS- 401: Environmental Law, Tools & Techniques and Research Methodology

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I - Environmental Law

- The National Wildlife action plan. Forest (conservation) Act, 1980, amended, 1988
- Mines and Minerals (development and regulation) act, 1957
- The Hazardous wastes (management and handling) amendment Rules, 2000
- The Recycled Plastics Manufacture and usage (Amendment) Rules, 2003
- The chemical Accidents (Emergency Planning, preparedness and response) rules, 1996
- Bio-medical waste (Management and Handling) (amendment) Rules, 2003
- The water (prevention and control of pollution) Act, 1977
- The air (Prevention and control of pollution) Act, 1981
- Noise Pollution (Regulation and Control) rules, 2000

Unit II - Tools and techniques

- Principle and working of pH meter, Conductivity meter, DO meter, Hygrometer, Rain gauge, Turbidity meter
- Spectroscopy: Spectrophotometer, Flame photometer, UV-spectrophotometer, AAS
- Chromatography: Paper TLC, HPLC, Gas Chromatography
- Sampling methods, Sampling for population study Plants, animals – aquatic and terrestrial
- Sampling of soil micro, meso and macro fauna

Unit-III - Research Methodology

- Application of various population and community indices and interpretation of result
- Use of statistical tools for interpretation of result from data generated
- Community analysis
- Techniques for data generation for EIA
- Toxicological study techniques for aquatic and terrestrial organisms
- Modelling in environmental studies

402-SPECIAL PAPER

EVS- 402 (Optional -I): Environmental Biotechnology and Clean Technology

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Concept of Bioremediation: Technology for Bioremediation, Bio- augmentation, Bio-stimulation
- Characteristics of bioremediating agent, Types of Bioremediation, applications
- Role of plants, animals and microbes in In-situ and Ex-situ bioremediation of contaminated ecosystems
- Some case Studies

Unit II

- Use of GEMs in bioremediation, Release of GEMs in environment
- Airborne microbes
- Suicide genes., Geno sensor technology
- Micro-electromechanical systems (MEMS); Gene probes; Nah Operon

Unit III

- Biotechnology for Management of Resources: Bio-transformation of heavy metals; Oil field microbiology; improved oil recovery
- Role of environmental biotechnology in management of resources
- Reclamation of wasteland; Biomass production; Biogas and biofuel production, Microorganisms in mineral and energy recovery
- Nanotechnology for control of pollution.

Unit IV

- Clean Technology: Imperatives of clean technology in the context of mitigation and adaptation measures
- CDM concept, CDM scenario in India, CDM projects sector-wise
- National Action Plan on Climate Change, sustainable habitat, concept of Green architecture
- Carbon trading; carbon credits; Carbon sequestration; Carbon Footprint. Issues of Energy security, Food Security and Social security.

Suggested Readings:

- Evano, G.H. and Furlong, J.C. Environmental Biotechnology – Theory and Application.John Wiley and Sons, USA. 2004.
- Jjemba, P.K. Environmental Microbiology – Theory and Application. Science Pub. Inc., USA. 2004.
- Olguin, C. J., Sanchez, G., Hernandez. E. Environmental Biotechnology and Cleaner Bioprocesses.Taylor & Francis.2000.
- Pepper, I.L. and Gerba, C.P. Environmental Microbiology - Laboratory Manaul. Elsevier, USA. 2005.
- Ratledge, C. and Kristiansen, B. Basic Biotechnology. 2nd ed. Cambridge University Press, Cambridge, UK. 2002.
- Rittman, B. and McCarty, P. L. Environmental Biotechnology: Principles and Applications.2nd edition. Tata McGraw-Hill, USA. 2000. 23
- Rittmann, B.E. and McCarty, P.L. Environmental Biotechnology – Theory and Application.McGraw Hill, USA. 2001.
- Silver C. S. and DeFries, R. S. One Earth one Future: - Our Changing Global Environment.East-West Press Edition, 1991.
- Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation.Anamaya Publishers, New Delhi, India. 2006.
- Speth, J. C. Global Environmental Challenges – Transitions to a Sustainable World.

EVS- 402 (Optional -II): Water Resource Conservation and Management

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Diversity of aquatic habitats; hydrological cycle, Aquatic food webs including microbial loop; trophic cascade. Measurement of aquatic primary productivity
- Lakes - Origin and classification, ecological zonation, thermal stratification, water circulation, physical and chemical characteristics
- Phytoplankton – diversity and models of nutrient-limited growth, paradox of plankton; a general account of zooplankton
- A general account of benthic and periphytic communities.

Unit II

- Characteristics of running water habitats; River Continuum Concept, self-purification.
- Oceans: Chemistry of seawater, circulation and ecological zonation in sea, marine biota, coral reefs
- General account of estuaries and wetlands.

Unit III

- Eutrophication: Causes, consequences and correctives
- Global distribution of water resources, water need and consumption;
- Threats to surface water resources
- Principles and approaches to surface water management. Watershed management: Rain water harvesting and storage, recharging of ground water; role of dams.

Unit IV

- Properties of sewage and industrial effluents; effluent standards; treatment of industrial effluents, sewage treatment (primary, secondary and tertiary treatment)
- Advanced treatments (nitrate and phosphate removal); Sludge treatment and disposal; Waste water use
- Drinking water quality and water treatment (desalination, ion-exchange, reverse osmosis and disinfection of water)

Suggested Readings:

- Dobson, M. and Frid, C. 1998.Ecology of Aquatic Systems.Longman.
- Adams, S.M. (Ed). 2002. Biological Indicators of Aquatic Ecosystem Stress. American Fisheries Society, Bethesda.
- Talling, J.F. and Lemoalle, J. 1998. Ecological Dynamics of Topical Inland Waters. Cambridge University Press.
- Wetzel, R.G. and Likens, G.E. 2000. Limnological Analysis.Springer-Verlag.
- Wetzel, R.G. 2000. Limnology: Lake and River Ecosystems. Academic Press
- Dodson, S. 2005. Introduction to Limnology. McGraw-Hill, New York.
- A.J. Schleiss and R.M. Boes. 2011. Dams and Reservoirs under Changing Challenges.CRC Press.
- J.N. Parkinson, J.A. Goldenfum and C.E.M. Tucci. 2010. Integrated Urban Water Management.CRC Press.
- A.N. Findikakis and K Saro. 2011. Groundwater Management Practices. CRC Press.

EVS- 402 (Optional -III) Environmental Education

Time- 3.00 hours **Full Marks- 70**
Pass Marks -28

Total seven questions are required to be set out of which first question will be compulsory and have ten objective type question carrying ten marks. Six subjective type questions will be set covering entire syllabus at least one question from each unit each carrying fifteen marks each. One question should be short notes type question. Examinees are required to answer four questions out of these six.

Unit I

- Environmental Education, Global &Indian Scenario
- History & Future Aspects, Agenda 21
- Earth Summit, Development Goals-17
- Kyoto Protocol, Montreal protocol, Vienna Convention

Unit II

- Governmental agencies: Environmental Protection Agencies (EPA)
- Ministry of Environment, Forest & Climate Change
- Indian Board Of Wild Life
- National wasteland Development Board

Unit III

- National Wetland Conservation Programme
- Coastal Area Regulation (CRZ)
- Central Pollution Control Board
- World Health Organization
- Environmental Economics: Introduction to Environmental Economics
- Values of Environment
- Ecology Vs Economy, Cost Benefit Analysis.

Unit IV

- Non-Governmental Agencies: World Wildlife Fund (WWF), IUCN, IES
- Different Rural and Urban Programme
- Case Studies: Sardar Sarovar Dam Project, Narmada Dam Project, Silent Valley Project, Chipko movement, Tehri Dam project.

Suggested Readings:

- Edgar G. et al, 2008, Environmental education, Sense Publishers
- J.M. Haris,2017, Environmental & natural Resource Economics: A Contemporary approach, 4th Edition, Routledge Publishers.

EVS- 403: Dissertation & Project

Distribution of Marks for evaluation of the Dissertation

Sl. No.	Practical	Marks Distributions
1	Project	50
2	PowerPoint presentation	10
3	Viva Voce	10
	Total	70

A dissertation project of minimum one month is to be carried out by the students in Reputed Institutes/ Laboratories/ Industries/ NGOs/University. A project Report along with a power point presentation is to be given in the exam.

Overall project dissertation may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship Programme with reputed organization
- Application of Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

Important instruction to students:

A. Each student must submit two copies of the dissertation work duly forwarded by the Head of the Department and duly signed by the supervisor concerned. The forwarded copies will be submitted to the concerned Department of University, for evaluation. The paper will consist of
    - Field work/Lab work related to the project
    - Preparation of dissertation based on the work undertaken.
    - Presentation of project works in the seminar on the assigned topic & open viva there on.

B. Each student shall have to complete a project work on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the Department.

C. Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.
D. Students will select topics for the project work in consultation with a teacher of the Department. The Seminar will be held in the concerned Department of University.

The Dissertation/Project shall be presented with the following specifications:

(a) Size of Paper: A4. Dissertation/Project must be printed on one side of the paper.
(b) Font Type: Times New Roman.
(c) Font Size: Font size for English text is 12pt. in standard form
(d) Font of Chapter Headings and Sub-Headings:

- Chapter headings may be written in all Capitals, bold text in font size 15
- Sub-headings are written with left margin alignment
- First level sub-headings are written in normal sentence case using bold text in point size 14
- Second level sub-headings are point size 13

(e) Spacing and Paragraphing:

- Printing shall be in standardized form with 1.5 line spacing
- Leave as triple spacing (2 empty lines) in base font size 12 before and after subheadings and one empty line after all sub-headings
- Use one empty line between left-justified paragraphs

(f) Margin: Left margin should be 4cms and right and top margin should be 2cms. Bottom margins should be 2.5cms. No ornamental bordering of sides is permitted.
(g) Page Numbering: Preliminary pages of the Dissertation/Project, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Pg. No 1 on the first page of chapter 1
(h) Preliminary sections of the Dissertation/Project should include, Declaration of Attendance, Certificate from Supervisor, Declaration by Candidate and Supervisor regarding Plagiarism, Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.
(i) Referencing and Citation Style: Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilized to support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc. The referencing of work and Citation style in the Dissertation/Project submitted in Faculty of Science (Environmental Science & Disaster Management) will be **in American Psychological Association (APA)** style (6th edition).

EVS- 404: Practical's Based Courses

F.M.: 100

1. Working Principles of different environmental monitoring Instruments.
2. Water Quality monitoring: Determination of water parameters: pH, Dissolved Oxygen, Total Solids, Total Suspended Solids, Total Dissolved Solids, BOD & COD, TOC.
3. Air Quality Monitoring as per NAAQS: Determination of PM 2.5 & PM 10, estimation of SOx, NOx, & CO, Ozone estimation.
4. Project Work
5. Viva Voce