



N.E.P. Syllabus - M.Sc. Environmental Science (Sem. – I)
Block – A, Department of Environment and Life Science,
KSKV Kachchh University, Bhuj



Syllabus - Structure

Semester – 01							
Courses	Course Code	Title of the Course	Course Type	Credit	Internal Marks	External Marks	Total Marks
Major	MJENS 101	Fundamentals of Earth and Environmental Systems	T	4	50	50	100
	MJENS 102	Ecosystems, Biogeochemistry and Microbial Ecology	T	4	50	50	100
	MJENS 103	Fundamentals of Environmental Analytical Techniques	T	4	50	50	100
	MJENS 104	Dryland and Marine Environmental Systems	T	4	50	50	100
	MJENS 105	Combined Practical - Environmental Laboratory, Ecological and Geospatial Methods (100 Practical + 50 Viva)	P	4	75	75	150
SEC	MNENS 106	Remote Sensing and GIS Applications in Environmental Science	T	2	25	25	50
Total Credits = 22			T/P	22	300	300	600

Internal Assessment: 50%

External Assessment: 50%





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2. **Analyze** atmospheric and hydrological processes, including climate variability, atmospheric chemistry, and the global water cycle under changing climatic conditions.
3. **Evaluate** oceanic and marine systems, including marine chemistry, biogeochemical cycles, and ocean-atmosphere interactions.
4. **Assess** lithosphere and soil systems, focusing on soil formation, properties, soil-water-climate interactions, and degradation processes.
5. **Interpret and apply** sustainability frameworks such as the Anthropocene, planetary boundaries, and Sustainable Development Goals (SDGs) in understanding environmental challenges.





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MJENS 102 Ecosystems, Biogeochemistry and Microbial Ecology (Credits – 4)

Unit I: Ecosystem Structure, Function, Energy Flow and Biogeochemical Cycles

- Basic concepts and scope of ecology, Principles of ecosystem organization and functioning
- Matter and energy in the environment; laws of thermodynamics, Energy flow in ecosystems; productivity (primary and secondary)
- Food chains, food webs and trophic levels, Ecological pyramids
- Biogeochemical cycles: carbon, nitrogen, phosphorus, sulphur, Gaseous, sedimentary and hydrological cycles, Role of microbes in nutrient cycling
- Ecological stoichiometry and nutrient limitation, Ecosystem services framework
- Role of ecosystems in climate regulation

Unit II: Population, Community, Habitat and Landscape Ecology

- Habitat ecology: freshwater, marine, estuarine, terrestrial, desert and arid/semi-arid systems
- Limiting factors: laws and combined concept
- Development and evolution of ecosystems, Ecotone, edge effect, ecades and ecotypes
- Population ecology: population dynamics and growth models, Ecological niche and niche modelling.
- Communities and community structure, Species interactions: competition, predation, mutualism, etc.
- Ecological succession
- Landscape ecology and ecosystem connectivity
- Metapopulation dynamics

Unit III: Biodiversity, Microbial Ecology and Systems Ecology

- Biodiversity and Conservation: Origin, speciation and extinction, Types of biodiversity: alpha, beta, gamma diversity
- Ecological role and functional importance of biodiversity
- Rare and endangered species; IUCN and Red Data Book
- Causes of biodiversity loss, Conservation theory and practices; protected areas and species, Conservation genetics, functional diversity and phylogenetic diversity
- Climate change and species distribution shifts
- Microbial Ecology:
- Microbial diversity in soil, water and extreme environments, Microbial flora: Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla, etc.
- Structure, behaviour and growth of microorganisms in relation to environment, Soil–plant–microbe interactions and rhizosphere processes, Microbial interactions with plants, animals and other microbes.
- Role of microbes in nutrient cycling (N, P transformations), Decomposition, mineralization and biotransformation of organic matter, Degradation of recalcitrant compounds.





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- Microbial responses to environmental change and ecosystem functioning, Microbiome ecology,
- Systems Ecology: Systems approach in ecology, Mathematical models in ecology (with examples)

Learning Objectives of MJENS102

By the end of this course, students will be able to:

- Explain ecosystem structure and functioning, including energy flow, productivity, and biogeochemical cycles governing ecological systems.
- Analyze population, community, and landscape-level ecological processes, including species interactions, succession, and habitat dynamics.
- Evaluate the role of biodiversity in ecosystem stability, along with conservation strategies and emerging challenges like climate-driven species shifts.
- Assess microbial diversity and functions in different environments, particularly their role in nutrient cycling, decomposition, and plant–microbe interactions.
- Interpret and Apply systems ecology approaches and conceptual models to understand and interpret





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MJENS 103 Fundamentals of Environmental Analytical Techniques (Credits

- 4)

Unit I: Fundamental Analytical Principles, Electrochemistry and Microscopy Analytical Fundamentals:

- Concepts of accuracy, precision, sensitivity, and error, Calibration methods and quality assurance/quality control (QA/QC), Sampling strategies and sample preparation in environmental analysis
- Electrochemical Techniques: Principles of electrochemistry, pH, buffers and their environmental significance, Potentiometric and conductometric methods and titrations
- Microscopy and Imaging Techniques: Principles and applications of light microscopy, Phase contrast and fluorescence microscopy, Scanning and transmission electron microscopy (SEM, TEM)
- Scanning tunneling microscopy (STM) and atomic force microscopy (AFM), Confocal microscopy, Cytophotometry and flow cytometry, Fixation and staining techniques
Sensor Technologies: Principles of biosensors, Introduction to environmental sensing approaches

**Unit II: Separation, Filtration, Centrifugation and Chromatographic Techniques
Separation Techniques:**

- Principles and applications of filtration, Centrifugation: basic principles and types (differential, density gradient, ultracentrifugation)

Chromatographic Techniques:

- Principles of chromatography and separation science
- Thin layer chromatography (TLC), Gas chromatography (GC), High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Ion-exchange and affinity chromatography, Gel filtration chromatography, Electrophoresis techniques

Advanced Analytical Techniques:

- Inductively Coupled Plasma techniques: ICP-MS and ICP-OES (introduction and applications), Liquid chromatography–mass spectrometry (LC-MS/MS): principles and environmental applications

**Unit III: Spectroscopic Techniques, Environmental Monitoring and Data Analysis
Spectroscopic Techniques:**

- Principles and applications of UV-Visible spectroscopy, Infrared (IR) spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy, Electron Spin Resonance (ESR) spectroscopy, X-ray diffraction (XRD) and X-ray fluorescence (XRF)

Environmental Monitoring and Field Instrumentation:

- Remote environmental sensing instruments, Basics of spectroradiometry, Environmental sensors and data loggers, Field-based environmental monitoring techniques





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Analytical Data Handling:

- Spectroscopic analysis of environmental samples, Basics of analytical data interpretation, Data reporting and presentation in environmental studies.

Learning Objectives of MJENS103

By the end of this course, students will be able to:

1. **Explain and apply** fundamental analytical principles, including electrochemical methods, calibration, and QA/QC, for environmental sample analysis.
2. **Demonstrate and evaluate** microscopy and imaging techniques for characterization of environmental and biological samples.
3. **Apply** separation techniques such as filtration, centrifugation, chromatography, and electrophoresis for qualitative and quantitative analysis.
4. **Analyze** environmental samples using advanced analytical and spectroscopic techniques (e.g., UV-Vis, IR, NMR, ICP-MS, LC-MS/MS).
5. **Interpret and report** analytical data using environmental monitoring tools, sensors, and standard data analysis protocols.





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MJENS 104 Dryland and Marine Environmental Systems - (Credits – 4)

Unit I: Marine Environment, Ecology and Coastal Systems

- Ocean as an ecosystem and classification of marine habitats, Marine environmental conditions: tides, temperature, wave action, salinity, nutrients and other factors
- Adaptations of intertidal organisms (rocky, sandy, muddy shores):
 - Resistance to water loss, heat balance, mechanical stress
 - Respiration, feeding, salinity stress, reproduction
 - Distribution patterns, feeding biology, community organization and zonation
- Important marine and coastal ecosystems: mangroves, coral reefs, mudflats, estuaries, lagoons, backwaters and brackish waters, Coastal and marine activities: ports, harbors, aquaculture, salt works and their ecological impacts
- Marine Protected Areas (MPAs), Ocean acidification and coral bleaching, Blue Economy concept

Unit II: Dryland Systems and Desertification Processes

- Definition of desertification and UNCCD framework, Genesis of the Convention to Combat Desertification (CCD), Status of drylands and desertification globally and in India, Climate and desertification: rainfall patterns, variability, and dryland climate (India-specific context)
- Major causes of desertification:
 - Unsustainable agricultural practices and shifting cultivation, Unsustainable water management, Land-use changes, Deforestation and loss of vegetative cover, Industrial and mining activities, Drought and land degradation
- Processes of desertification:
 - Soil erosion (wind and water), Salinity, alkalinity and waterlogging
- Dryland agriculture and climate resilience
- Carbon dynamics in arid and semi-arid ecosystems

Unit III: Impacts, Monitoring and Management of Desertification Impacts of Desertification:

- Impact of population pressure on forest resources, Impacts on biodiversity and ecosystem services, Livestock pressure on grazing and forest lands, Depletion of vegetative cover, Soil degradation: wind and water erosion, fertility loss, Impacts of inefficient water management, Impacts on quality of life and livelihoods, Linkages with climate change

Management and Mitigation Strategies:

- Policy, strategy and legislative frameworks (national and global), Environmental conservation strategies and institutional frameworks, Programmes and technologies for combating desertification (soil, water and vegetation conservation), National programmes: DDP, DPAP, IGNP





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- Traditional and indigenous technologies, Interlinking national efforts with regional and global initiatives, Nature-based solutions (NbS) for land restoration, Role of remote sensing and geospatial tools in desertification monitoring

Learning Objectives MJENS104

By the end of this course, students will be able to:

1. **Explain** the structure and functioning of marine ecosystems, including organismal adaptations and coastal ecological processes.
2. **Analyze** the causes, processes, and spatial patterns of desertification in global and Indian dryland systems.
3. **Evaluate** the ecological, socio-economic, and climatic impacts of desertification and land degradation.
4. **Assess** strategies, policies, and technologies for desertification control, including traditional knowledge and nature-based solutions.
5. **Apply** tools such as remote sensing and environmental monitoring approaches for assessment and management of dryland and coastal ecosystems.





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MJENS 105 Combined Practical (Credits – 4)

1. GLP (Good Laboratory Practices)
2. Preparation of Standards and other experimental chemicals and reagents
3. Study of cleaning and sterilization of glass ware
4. Study of Basic Laboratory Instruments
 - a. pH Meter
 - b. Spectrophotometer
 - c. Oven
 - d. Microscope etc.
5. Staining Techniques
 - a. Monochrome Staining
 - b. Negative Staining
 - c. Grams's Staining
 - d. Endospore Staining
6. Isolation techniques of micro organism from water, soil and air sample
7. Microbial Diversity
8. Determination of atmospheric humidity
9. Physical properties of soil
10. Quadrates and Species identification
11. Estimation of different types of alkalinity from given samples
12. Estimation of Dissolve CO₂ from given samples
13. Understanding the topographic map
14. Conservation of map units
15. Registration of map and digitisation
16. Preparation of map by using ARC GIS
17. Understanding of image process by using ERDAS
18. Field visit and Report preparation





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Learning Objectives of MJENS105

By the end of this practical course, students will be able to:

1. Demonstrate good laboratory practices (GLP), including preparation of reagents, sterilization techniques, and safe handling of laboratory instruments.
2. Apply microbiological techniques such as staining, isolation, and assessment of microbial diversity from environmental samples (soil, water, air).
3. Measure and analyze environmental parameters, including atmospheric humidity, soil properties, alkalinity, and dissolved CO₂ using standard methods.
4. Perform ecological field methods such as quadrat sampling and species identification, and interpret field data.
5. Utilize geospatial tools (topographic maps, GIS, and remote sensing software like ArcGIS and ERDAS) for map preparation, digitization, and environmental data analysis.





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**MNENS 106 Remote Sensing and GIS Applications in Environmental Science
(Credits – 2)**

Unit I: Fundamentals of Remote Sensing and Photogeology

- Fundamental concepts and principles of remote sensing
- Electromagnetic radiation and its interaction with atmosphere and Earth surface features; Spectral signatures of natural features (soil, water, vegetation)
- Satellite platforms and sensors: optical, thermal, microwave
- Multi-spectral scanners, thermal scanners and microwave remote sensing
- Image acquisition and resolution concepts: spatial, spectral, temporal
- Elements of photographic systems and aerial photography, Aerial photo interpretation and geological applications
- Fundamentals of photogrammetry, Basics of image interpretation and environmental/geological applications

Unit II: Geographic Information Systems (GIS) and Spatial Analysis

- Introduction to Geographic Information Systems (GIS)
- Spatial data models and structures: vector and raster
- Data input, storage, management and retrieval
- Map projections and coordinate systems
- Visualization and querying of spatial data, Spatial analysis techniques: overlay, buffering, interpolation
- Introduction to digital image processing, GIS software applications (ArcGIS/ERDAS or equivalent), Applications in environmental mapping, geological studies and resource assessment

Unit III: Applied Geoinformatics, GPS and Environmental Data Analysis

- Introduction, principles and working of GPS
- Topographic maps, georeferencing and digitization
- Introduction to remote sensing data processing
- Environmental data handling, analysis and visualization
- Applications in land use, biodiversity and ecosystem monitoring
- Drone/UAV-based environmental monitoring
- Google Earth Engine basics
- Machine learning applications in GIS and geospatial analysis

By the end of this course, students will be able to:

1. **Explain the principles of remote sensing, including electromagnetic radiation, sensor technologies, and image acquisition.**





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2. Interpret remote sensing data and aerial photographs for environmental and geological applications.
3. Apply GIS concepts, spatial data models, and analytical tools for mapping and spatial decision-making.
4. Analyze geospatial data using modern tools such as GPS, remote sensing software, and digital image processing techniques.
5. Evaluate and utilize advanced geospatial technologies (e.g., UAVs, Google Earth Engine, machine learning) for environmental monitoring and resource management.

Suggested References

Course	Unit	Topic	Reference Books
MJENS 101	Unit I	Basics of Environment	Miller, G. Tyler & Spoolman, Scott E. (2021). Environmental Science, 16th Ed., Cengage. Cunningham, W.P. & Cunningham, M.A. (2020). Principles of Environmental Science, 9th Ed., McGraw Hill. Marsh, W.M. & Grossa, J.M. (2018). Environmental Geography, Wiley. Rockström, J. et al. (2018). Planetary Boundaries. Sachs, Jeffrey D. (2015). The Age of Sustainable Development. Gilbert M. Master (2014). Introduction to Environment Engineer and Science.
MJENS 101	Unit II	Atmosphere and Hydrosphere	Wallace, J.M. & Hobbs, P.V. (2006). Atmospheric Science, 2nd Ed., Academic Press. Seinfeld, J.H. & Pandis, S.N. (2016). Atmospheric Chemistry and Physics, 3rd Ed., Wiley. Ahrens, C.D. (2018). Meteorology Today, 12th Ed., Cengage. Dingman, S.L. (2015). Physical





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			Hydrology. Brutsaert, W. (2005). Hydrology: An Introduction.
MJENS 101	Unit III	Marine Chemistry and Lithosphere	Libes, S.M. (2011). Introduction to Marine Biogeochemistry. Pilson, M.E.Q. (2013). An Introduction to the Chemistry of the Sea. Brady, N.C. & Weil, R.R. (2016). The Nature and Properties of Soils. White, R.E. (2013). Principles and Practice of Soil Science. Lal, R. (2020). Soil Health and Climate Change.
MJENS 102	Unit I	Ecology, Energy and Biogeochemical Cycles	Odum, E.P. & Barrett, G.W. (2005). Fundamentals of Ecology. Begon, M. et al. (2021). Ecology: From Individuals to Ecosystems. Molles, M.C. (2019). Ecology: Concepts and Applications. Stern, R.W. & Elser, J.J. (2002). Ecological Stoichiometry. Daily, G.C. (1997). Nature's Services.
MJENS 102	Unit II	Population and Habitat Ecology	Krebs, C.J. (2016). Ecology. Turner, M.G. et al. (2015). Landscape Ecology in Theory and Practice. Gotelli, N.J. (2008). A Primer of Ecology.
MJENS 102	Unit III	Biodiversity and Microbial Ecology	Primack, R.B. (2020). Essentials of Conservation Biology. Atlas, R.M. & Bartha, R. (2010). Microbial Ecology. Loreau, M. (2010). From Populations to Ecosystems. Frankham, R. et al. (2019). Introduction to Conservation Genetics.





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MJENS 103	Unit I	Electrochemistry and Microscopy	Skoog, D.A. et al. (2017). Principles of Instrumental Analysis. Willard, H.H. et al. (1988). Instrumental Methods of Analysis. Wilson, K. & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology.
MJENS 103	Unit II	Chromatography	Meyer, V.R. (2010). Practical High-Performance Liquid Chromatography. Snyder, L.R. et al. (2012). Introduction to Modern Liquid Chromatography.
MJENS 103	Unit III	Spectroscopy	Harris, D.C. (2015). Quantitative Chemical Analysis. Rouessac, F. & Rouessac, A. (2013). Chemical Analysis.
MJENS 104	Unit I	Marine Environment	Castro, P. & Huber, M.E. (2018). Marine Biology. Nybakken, J.W. & Bertness, M.D. (2005). Marine Biology: An Ecological Approach.
MJENS 104	Unit II	Desertification	Middleton, N. & Thomas, D. (1997). World Atlas of Desertification. Dregne, H.E. (1986). Desertification of Arid Lands.
MJENS 104	Unit III	Desertification Management	Reynolds, J.F. & Stafford Smith, D.M. (2002). Global Desertification. Thomas, D.S.G. (2011). Arid Zone Geomorphology.
MJENS 106	All Units	Environmental Chemistry	Manahan, S.E. (2021). Environmental Chemistry. De, A.K. (2018). Environmental Chemistry. Baird, C. & Cann, M. (2012). Environmental Chemistry.
MNENS 106	All Units	Remote Sensing and GIS	Lillesand, T.M. et al. (2015). Remote Sensing and Image Interpretation.





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			Burrough, P.A. & McDonnell, R.A. (2015). Principles of GIS. Chang, K.T. (2019). Introduction to GIS.
MJENS 105	Practical	Laboratory References	APHA (2023). Standard Methods for the Examination of Water and Wastewater. Trivedy, R.K. & Goel, P.K. (2017). Practical Methods in Ecology and Environmental Science.

(Dr. Mrugesh H. Trivedi)

BoS Chairman



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Syllabus - Structure

Semester – 02							
Courses	Course Code	Title of the Course	Course Type	Credit	Internal Marks	External Marks	Total Marks
Major	MJENS 201	Environmental Pollution and Control Technologies	T	4	50	50	100
	MJENS 202	Applied Climatology, Ocean Dynamics and Climate Variability	T	4	50	50	100
	MJENS 203	Research Methodology, Biostatistics and Computer Applications	T	4	50	50	100
	MJENS 204	Industrial Safety, Disaster Management and Risk Reduction	T	4	50	50	100
	MJENS 205	Combined Practical – Environmental Analysis, Pollution Monitoring and Applied Environmental Techniques (100 Practical + 50 Viva)	P	4	75	75	150
SEC	MNENS 206	Environmental Geology and Economics	T	2	25	25	50
Total Credits = 22			T/P	22	300	300	600

Internal Assessment: 50%

External Assessment: 50%





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MJENS 201 - Environmental Pollution and Control Technologies

Unit I: Fundamentals of Pollution and Atmospheric Pollution Processes

- Definition, concepts and classification of pollution and pollutants
- Types, origin, properties and sources of pollutants
- Composition and structure of atmosphere
- Primary and secondary air pollutants
- Major air pollutants: PM_{2.5}, PM₁₀, VOCs, black carbon, methane, tropospheric ozone
- Behaviour, transport, transformation and fate of air pollutants in atmosphere
- Photochemical smog and atmospheric reactions
- Greenhouse gases, global warming and climate pollutants
- Chlorofluorocarbons (CFCs) and ozone layer depletion
- Carbon footprint and emission inventories
- Indoor air pollution and associated health impacts
- Air Quality Index (AQI): concept, calculation and interpretation
- Atmospheric stability, lapse rates, wind systems, turbulence and plume behaviour
- Dispersion of pollutants and Gaussian plume model (basic concept)
- Air pollution monitoring techniques and sampling methods
- Continuous Ambient Air Quality Monitoring Systems (CAAQMS)
- Remote sensing applications in air pollution monitoring
- Source apportionment studies, Air pollution control methods and equipment,
- Ambient air quality standards

Unit II: Water, Marine and Thermal Pollution

- Introduction, definition, sources and types of water pollutants
- Surface water and groundwater pollution
- Physical, chemical and biological effects of water pollution
- Wastewater treatment processes: preliminary, primary, secondary and tertiary treatment
- Removal of suspended and dissolved solids, nitrogen and phosphorus
- Advanced biological treatment systems and chemical oxidation processes
- Resource recovery from process effluents and Water purification methods
- Wastewater reuse and recycling technologies
- Nature-based wastewater treatment systems (constructed wetlands)
- Marine pollution: sources and nature of pollutants
- Oil spills and oil pollution
- Heavy metals and metallic pollutants in marine systems
- Coastal and estuarine pollution in India
- Marine plastic pollution and microplastics
- Emerging contaminants: pharmaceuticals and PFAS
- Sea level rise: causes, impacts and control measures





- Chemicals and drugs from oceans
- Thermal pollution: concept, sources and impacts
- Thermal power plant pollution
- Effects of thermal pollution on water quality and marine life
- Prevention and control of thermal pollution

Unit III: Soil, Noise, Radiation and Solid Waste Pollution Management

Soil Pollution:

- Sources, types and processes of soil pollution
- Soil degradation and contamination
- Soil pollution management and remediation
- Integrated Pest Management (IPM) and Integrated Nutrient Management (INM)
- Land restoration approaches

Noise Pollution:

- Characteristics and sources of noise pollution
- Measurement and standards of noise as well as noise indices and numerics
- Impacts of noise pollution on humans and environment
- Noise control and mitigation measures

Radiation Pollution:

- Sources and types of radiation pollution
- Biological effects of radiation
- Radiation safety and control measures

Solid and Hazardous Waste Management:

- Municipal, industrial, biomedical and hazardous wastes
- Waste handling, segregation and disposal methods
- Waste treatment technologies: incineration, pyrolysis and composting
- Resource recovery and circular economy approaches

Learning Objectives of MJENS201

By the end of this course, students will be able to:

1. **Explain** the sources, characteristics, behaviour, and impacts of major environmental pollutants in air, water, soil, and marine systems.
2. **Analyze** atmospheric processes influencing air pollution, including dispersion, photochemical reactions, climate pollutants, and monitoring approaches.
3. **Evaluate** water and wastewater treatment technologies, marine pollution issues, and emerging contaminants affecting aquatic ecosystems.
4. **Assess** the environmental and health impacts of soil, noise, radiation, and solid waste pollution along with appropriate management strategies.





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5. **Apply** pollution monitoring, control technologies, and sustainable environmental management practices for pollution prevention and resource recovery.





MJENS 202 - Applied Climatology, Ocean Dynamics and Climate Variability

Unit I: Weather Dynamics and Applied Climatology

- Atmospheric circulation systems and climate regulation
- Dynamics of air masses, fronts, cyclones and anticyclones
- Monsoon dynamics and seasonal weather systems
- Mechanisms of extreme weather events
- Thunderstorms, lightning and severe atmospheric phenomena
- Climate classification systems and climatic controls
- Urban and regional climate modifications
- Heat waves, droughts and floods: causes and trends
- Climate variability and teleconnections
- Applied climatology in agriculture, water resources and disaster management

Unit II: Physical Oceanography and Ocean–Climate Interactions

- Ocean circulation dynamics: surface and deep-water circulation
- Thermohaline circulation and global conveyor belt
- Coastal hydrodynamics: tides, waves and coastal currents
- Upwelling and downwelling processes
- Air-sea interaction and ocean heat transport
- ENSO, Indian Ocean Dipole (IOD) and monsoon coupling
- Tropical cyclones over Indian seas
- Ocean carbon exchange and marine climate regulation
- Sea-level variability and coastal vulnerability assessment
- Marine biogeochemical processes and ocean productivity

Unit III: Climate Change Science, Monitoring and Environmental Applications

- Climate change indicators and observational evidence
- Climate forcing mechanisms and feedback processes
- Paleoclimate reconstruction techniques
- Stable and radiogenic isotopes in climatology and oceanography
- Climate modelling: concepts, scenarios and projections
- Climate datasets and environmental data interpretation
- GIS and remote sensing applications in climate studies
- Climate risk and vulnerability assessment
- Impacts of climate change on ecosystems, agriculture and coastal regions
- Adaptation, mitigation and resilience strategies
- IPCC assessments, UNFCCC and global climate governance





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Learning Objectives of MJENS202

By the end of this course, students will be able to:

1. **Explain** atmospheric processes, weather systems, and climatic controls governing regional and global climate patterns.
2. **Analyze** ocean circulation, ocean–atmosphere interactions, and their role in regulating monsoon systems and climate variability.
3. **Evaluate** the causes and impacts of extreme climatic events, sea-level changes, and climate variability on environmental and human systems.
4. **Apply** climate monitoring tools, isotopic techniques, GIS, and remote sensing approaches for climatological and oceanographic studies.
5. **Assess** climate change impacts, vulnerability, adaptation, and mitigation strategies within national and global environmental frameworks.





MJENS 203 Research Methodology, Biostatistics and Computer Applications

- Nature, characteristics and types of scientific research
- Research planning, experimental design and research methodology
- Sampling techniques and sampling designs
- Research problem identification and hypothesis formulation
- Preparation of research proposals and project planning
- Literature review techniques and scientific information retrieval
- Scientific writing: research papers, review articles, theses, conference reports, project reports and book reviews
- Referencing styles, citation methods and scientific abbreviations
- Preparation and delivery of scientific presentations
- Research ethics, plagiarism and UGC ethical guidelines
- Reference management tools: Mendeley and Zotero
- Scientific data visualization techniques
- Introduction to systematic review and meta-analysis

- Scope and applications of biostatistics in environmental research
- Sampling theory and statistical data collection
- Data presentation: tabular, graphical and diagrammatic methods
- Measures of central tendency, dispersion and standard error
- Probability concepts and probability distributions: binomial, Poisson and normal distribution
- Hypothesis testing, types of errors and levels of significance
- Parametric statistical tests: Student's t-test, analysis of variance (ANOVA), chi-square test and goodness of fit
- Correlation and regression analysis
- Non-parametric statistical tests: Mann–Whitney U test and Kruskal–Wallis test
- Introduction to multivariate analysis: Principal Component Analysis (PCA) and cluster analysis
- Environmental data interpretation and statistical inference

- History, development and types of computers
- Computer hardware, software and peripheral devices





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- Operating systems: DOS, Windows and Linux (basic concepts)
- Spreadsheet tools and data management techniques
- Microsoft Office applications in scientific research
- Internet browsing and scientific information databases
- Introduction to statistical software: R and SPSS
- Basics of GIS data handling and environmental datasets
- Data processing, spreadsheet modelling and visualization techniques
- Use of scientific databases and digital repositories
- Preparation of scientific reports, graphs and presentations using computer applications
- Introduction to environmental databases and digital data management systems
- AI based research tools and its applications

Learning Objectives of MJENS203

By the end of this course, students will be able to:

1. **Design and formulate** scientific research problems using appropriate research methodologies, sampling strategies and experimental designs.
2. **Prepare and communicate** scientific documents, research proposals and presentations following ethical guidelines and standard referencing practices.
3. **Apply** statistical tools and biostatistical methods for analysis and interpretation of environmental and scientific data.
4. **Utilize** computer applications, statistical software and digital tools for data management, visualization and scientific analysis.
5. **Interpret and evaluate** research findings using quantitative approaches, scientific databases and modern analytical techniques for environmental research.







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- Early warning systems and technology integration in disaster management
- Post-disaster recovery and resilience planning
- Institutional frameworks and policies: NDMA, SDMA and Disaster Management Act
- Climate change adaptation and disaster resilience
- Management of spontaneous volunteers during disasters
- Case studies: Uttarakhand floods, Odisha cyclones and other Indian disasters
- Sustainable and resilient urban planning (suggested modern addition)

Learning Objectives of MJENS204

By the end of this course, students will be able to:

1. **Identify and assess** industrial and environmental hazards using appropriate safety and risk assessment approaches.
2. **Analyze** the causes, mechanisms and impacts of natural and anthropogenic disasters in different environmental settings.
3. **Apply** disaster management principles, preparedness strategies and emergency response techniques for risk reduction.
4. **Evaluate** the role of policies, institutional frameworks, GIS tools and early warning systems in disaster resilience and management.
5. **Develop** sustainable and community-based approaches for industrial safety, climate resilience and post-disaster recovery planning.





MJENS-205: Combined Practical – Environmental Analysis, Pollution Monitoring and Applied Environmental Techniques

Module I: Advanced Water and Soil Analysis

1. Determination of physical characteristics of water: colour, turbidity, TDS, TSS, dissolved solids, acidity and alkalinity
2. Determination of Dissolved Oxygen (DO)
3. Determination of Biological Oxygen Demand (BOD)
4. Determination of Chemical Oxygen Demand (COD)
5. Estimation of chloride in water and soil samples
6. Determination of total calcium and magnesium
7. Determination of total nitrogen, phosphorus and organic carbon from environmental samples
8. Drinking water analysis using Membrane Filter Technique (MFT) for coliform detection
9. Soil salinity and nutrient assessment (advanced continuation from Semester I soil practicals)

Module II: Environmental Microbiology and Bioremediation Techniques

10. Assessment of microbial diversity in environmental samples
11. Biotransformation of metals (iron and copper)
12. Bioremediation of metal-contaminated samples
13. Ferrous bio-oxidation and sulphur oxidation studies
14. Biodeterioration studies and microbial degradation processes
15. Microbial applications in environmental remediation (advanced extension beyond Semester I isolation techniques)

Module III: Air Pollution and Environmental Monitoring

16. Basic air quality monitoring techniques
17. Monitoring of suspended particulate matter (SPM) and aerosols
18. Air Quality Index (AQI) calculation and interpretation
19. GIS-based noise mapping (basic applications)
20. Environmental monitoring data recording and interpretation

Module IV: Biodiversity, Waste Assessment and Environmental Data Analysis

21. Study and identification of marine biodiversity and associated species
22. Waste characterization and segregation studies
23. Basic statistical analysis using Excel/R for environmental datasets
24. Environmental case study preparation on pollution/disaster events





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25. Interpretation and presentation of environmental datasets

Module V: Field Visit and Environmental Reporting

26. Industrial visit for study of Effluent Treatment Plant (ETP)/Sewage Treatment Plant (STP)
27. Field-based environmental data collection techniques
28. Preparation of scientific field reports and environmental audit summaries

Learning Objectives of MJENS205

By the end of this practical course, students will be able to:

1. **Perform** physicochemical and microbiological analysis of environmental samples using standard laboratory protocols.
2. **Apply** environmental monitoring techniques for assessment of air, water and soil quality parameters.
3. **Demonstrate** bioremediation and microbial transformation techniques relevant to environmental management.
4. **Analyze and interpret** environmental datasets using statistical tools, AQI calculations and GIS-based approaches.
5. **Prepare** scientific field reports and evaluate industrial and environmental management practices through field-based observations.





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MNENS 206 Environmental Geology and Economics

Unit I: Fundamentals of Environmental Geology and Earth Resources

- Concept and classification of minerals and rocks
- Formation of igneous, sedimentary and metamorphic rocks
- Weathering, erosion and soil formation processes
- Soil properties and soil degradation
- Geological hazards: earthquakes, floods, landslides, volcanism and tsunamis
- Geogenic contamination: arsenic and fluoride
- Mineral, groundwater and energy resources (coal, oil and gas)
- Environmental impacts of mining and resource extraction

Unit II: Environmental Economics and Natural Resource Management

- Relationship between environment and economy
- Public goods, externalities and market failure
- Natural resources: renewable and non-renewable resources
- Environmental valuation and environmental costs
- Environmental policy instruments: command-and-control, incentives and subsidies
- Carbon credits, green taxation and environmental accounting
- Sustainable resource utilization and conservation strategies

Unit III: Sustainable Development, Climate Change and Environmental Governance

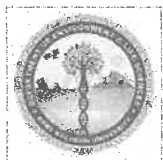
- Concept and principles of sustainable development
- Environmental Kuznets Curve (EKC) and economic growth
- Climate change and environmental sustainability
- Green GDP, ESG (Environmental, Social and Governance) and sustainable finance
- Disaster mitigation and environmental risk management
- Environmental governance and policy frameworks
- Environmental issues related to geology: Indian perspective
- Climate economics and sustainable development planning

Learning Objectives of MNENS206

By the end of this course, students will be able to:

1. **Describe** geological processes, Earth resources and environmental hazards.





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2. **Explain** environmental and economic impacts associated with natural resource utilization.
3. **Interpret** principles of environmental economics, valuation and policy instruments.
4. **Analyze** relationships between climate change, economic development and environmental sustainability.
5. **Apply** concepts of sustainable development, governance and environmental management to contemporary environmental issues.





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References suggested:

MSc Environmental Science Semester II - Reference Books (Unit-wise)

Course	Unit	Topic	Reference Books
CCEN-207	Unit I	Air Pollution	Cooper & Alley (2011); Seinfeld & Pandis (2016); Vallero (2014)
CCEN-207	Unit II	Meteorology	Arya (1999); Holton (2004)
CCEN-207	Unit III	Water Pollution	Metcalf & Eddy (2014); Sawyer et al. (2003)
CCEN-208	Unit I	Soil Pollution	Alloway (2013); Adriano (2001)
CCEN-208	Unit II	Noise & Radiation	Khitoliya (2012); Knoll (2010)
CCEN-208	Unit III	Solid Waste	Tchobanoglous et al. (1993); Wilson (2007)
CCEN-209	Unit I	Research Methodology	Kothari (2004); Day & Gastel (2012)
CCEN-209	Unit II	Biostatistics	Zar (2010); Daniel (2010)
CCEN-209	Unit III	Computer Applications	Crawley (2012); Field (2013)
CCEN-210	Unit I	Industrial Safety	Crowl & Louvar (2011); Goel (2007)
CCEN-210	Unit II	Disaster Concepts	Coppola (2015); Alexander (2002)
CCEN-210	Unit III	Disaster Management	Singh (2010); Carter (2008)
ICEN-211	All Units	Environmental Geology	Keller (2011); Krynine & Judd (2002)
ICEN-212	All Units	Environmental Economics	Tietenberg & Lewis (2018); Pearce & Turner (1990)

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