VEER NARMAD SOUTH GUJARAT UNIVERSITY
SURAT

M. Sc. ENVIRONMENTAL SCIENCE
SYLLABUS (CBCS)

With Effect from 2018-19
1. M. Sc. Environmental Science course will run on semester basis.
2. Each semester will be of fifteen (15) Weeks.
3. The whole course will be of two years (Four Semesters).
4. Proposed Teaching and Examination Scheme will be as per Annexure-I.
5. Syllabus of M. Sc. Environmental Science course (semester I, II) will be as per Annexure-II.
6. Examination system and passing standards will be as per VNSGU CBCS Norms.

Eligibility:

Candidates with Bachelor's Degree of a recognized University in Bio-Sciences/ Life Sciences, Agriculture, Fire-Safety, Environment Safety, Chemistry, Zoology, Botany, Microbiology, Environmental Sciences, Medical Technology, Bio-Technology with at least 40% marks will be Eligible.
ANNEXURE I

Teaching and Examination Scheme
of
M. Sc. Environmental Science Course
(Semester I, II)
## Teaching and Examination Scheme

### FIRST SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Theory (hrs/wk)</th>
<th>Practical (hrs/wk)</th>
<th>Exam Hours :3 External Marks</th>
<th>Internal Marks</th>
<th>Total Marks</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Ens. 101</td>
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<td>-</td>
<td>70</td>
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<td>-</td>
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<td>Analytical Techniques</td>
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<td>-</td>
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<tr>
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<td><strong>180</strong></td>
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### SECOND SEMESTER

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<th>Course Title</th>
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<th>Practical (hrs/wk)</th>
<th>Exam Hours :3 External Marks</th>
<th>Internal Marks</th>
<th>Total Marks</th>
<th>Credit</th>
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<td>Water and Wastewater Management</td>
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<td>-</td>
<td>70</td>
<td>30</td>
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<td>Ens. 202</td>
<td>Advances in Environmental Biotechnology</td>
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<td>-</td>
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<tr>
<td>Ens. 203</td>
<td>Environmental Informatics &amp; Statistics</td>
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<td>Instrumentation in Environmental Analysis - I</td>
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<td>-</td>
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</tbody>
</table>
ANNEXURE II

Syllabus of M. Sc. Environmental Science Course (Semester I, II)
FIRST SEMESTER

Ens: 101 Earth Science & Geology

Total Hours: 48

1. Foundations of Environmental Geology 12 Hours
   1.1 Introduction and fundamental of environmental geology
   1.2 Earth system and cycles: energy, hydrological, biogeochemical,
       rock and uniformitarianism and earth cycles
   1.3 Composition of the earth
   1.4 The earth: inside and outside

2. Contaminants in Geological Environment and Management 12 Hours
   2.1 Behavior of contaminants in environment
   2.2 Toxic contamination, acidic and caustic effluent
   2.3 Waste disposal: solid, liquid, hazardous and radioactive waste
   2.4 Waste management and geology

3. GIS and Remote Sensing 12 Hours
   3.1 Introduction and history of GIS and remote sensing
   3.2 Types of remote sensing and characteristics of images:
       photographic, digital, and microwave
   3.3 Ground truth data and Global Positioning System
   3.4 Geospatial analysis

4. External Influences and Disturbance 12 Hours
   4.1 Ecological disturbance
   4.2 Volcanic disturbance
   4.3 Cosmic disturbance
   4.4 Global Warming

References

FIRST SEMESTER
Ens: 102 Environmental Chemistry

Total Hours: 48

1. Atmospheric Chemistry 12 Hours
   1.1 Chemical & biochemical process in evolution of the atmosphere
   1.2 Self-purification of atmosphere
   1.3 Physical characteristic of atmosphere
      1.3.1 Variation of pressure and density with altitude
      1.3.2 Stratification of atmosphere
   1.4 Energy & mass transfer in the atmosphere
   1.5 Global climate & microclimate

2. Aquatic Chemistry 12 Hours
   2.1 H₂O - remarkable molecule: important properties of water
   2.2 Chemistry of water
   2.3 Complexation and chelation
   2.4 Occurrence and importance of chelating agents in water
   2.5 Complexation by humic Substances
   2.6 Importance & formation of sediments
   2.7 Solubility of solids & gases

3. Soil Chemistry 12 Hours
   3.1 Structure & composition of soil
   3.2 Acid-base & ion exchange reaction in soil
   3.3 Micro & macro nutrients in soil
   3.4 Nitrogen pathways & N, P, K in soil
   3.5 Soil fertility & productivity

4. Geochemistry 12 Hours
   4.1 Geochemistry & weathering of rocks in the Geosphere
      4.1.1 Physical aspect of weathering
      4.1.2 Chemical aspect of weathering
      4.1.3 Biological aspect of weathering
   4.2 Clays-important weathering products
   4.3 Sediment
   4.4 Ground water in the geosphere water wells & the Arsenic problem
References

5. Principles of Environmental Chemistry, James E. Girard, 3\textsuperscript{rd} Edition, 1\textsuperscript{st} Indian Edition 2015, Jones and Barrlett India Pvt. Ltd.
FIRST SEMESTER

Ens: 103 Environmental Microbiology

Total Hours: 48

1. Significance, History and Challenges of Environmental Microbiology  12 Hours
   1.1 Concept and significance of environmental microbiology
   1.2 Brief history of environmental microbiology
   1.3 Complexity of our world
   1.4 Many disciplines and their integration

2. Exploitation by Microorganisms  12 Hours
   2.1 Diverse habitats and evolutionary insights from genomics
   2.2 A planet of complex mixtures in chemical disequilibrium: thermodynamics, electron transport and syntrophy
   2.3 Key traits of cultured microorganisms from Eukarya, Bacteria and Archaea
   2.4 Uncultured microorganism and microbial diversity by genomics, HGT and cell size

3. Special and Applied Topics in Environmental Microbiology  12 Hours
   3.1 Microbial resident of plants and humans and antibiotic resistance
   3.2 Definition, methods and application of biodegradation, bioremediation and biodeterioration
   3.3 Definition, methods and application of biofilm, biofuel, biogas and biofertilizers
   3.4 Evolution of catabolic pathways for organic contaminants

4. Future frontiers in Environmental Microbiology  12 Hours
   4.1 Overview methods for determining the position and composition of microbial community
   4.2 Metagenomics and related methods: procedure and insights
   4.3 Influence of system biology on ecological niches and their genetic basis
   4.4 Concepts help define future progress in environmental microbiology
References

FIRST SEMESTER
Ens: 104 Analytical Techniques

Total Hours: 48

1. Chemistry for Environmental Science
   12 Hours
   1.1 Chemical equations, stoichiometry & mass balance, redox & half reactions
   1.2 Chemical equilibrium & variations, ways of shifting chemical equilibria
   1.3 Electrochemistry: electrochemical cell, galvanic protection
   1.4 Chemical kinetics: zero, first, second order reactions, consecutive reactions, enzyme reactions, gas liquid mass transfer kinetics, temperature dependence of reaction rates
   1.5 Thermodynamics: first and second law of thermodynamic- enthalpy- entropy
   1.6 Environmental applications of above topics

2. Sampling and Standardization
   12 Hours
   2.1 ISI methods for collecting samples of water
   2.2 Preservation of samples
   2.3 Permissible limits according to BIS & WHO, GPCB, CPCB
   2.4 Primary and secondary standards
   2.5 Preparation and standardization of standard solutions: Sodium hydroxide, Potassium permanganate, Iodine, Sodium thiosulphate

3. Analysis of Water and Waste Water
   12 Hours
   Principle, reaction mechanism, analysis method, environmental significance and applications of water quality parameters
   Gravimetric Analysis:
   3.1 Solids by drying method, Oil and grease by solvent extraction method
   3.2 Buffers and buffer index, examples and applications
   Volumetric Analysis:
   3.3 Acid-base titrations: P,M and Total Alkalinity, Ammonical Nitrogen
   3.4 Precipitation titrations: CI & Complexometric titration: Ca^{2+},Mg^{2+},Total Hardness
   3.5 Redox titrations: Iron ,COD & Iodometric titrations: FRC, DO, BOD

4. On-Line Analyzers:
   12 Hours
   4.1 Online pH analyzers: principle, types of different pH electrodes, application
   4.2 Online DO analyzers: principle, types of different cells and sensors, application
   4.3 ORP measurement: principle, equipment, application, ORP control
   4.4 Online FRC analyzers: principle, types of FRC sensors, applications
   4.5 On-line Turbidity, Sludge and Suspended Solid measurement: turbidity units, forward scattering transmission types, dual beam design, laser type suspended solid and sludge density sensors, scattered light detectors, backscatter turbidity analyzers
   4.6 Water quality monitoring: purpose of water quality measurement, sampling system, different sensors and analyzers
References:

FIRST SEMESTER  
Ens:105  Practicals

Environmental Chemistry, Analytical Techniques
1. Determination of pH and moisture in soil sample.
2. Determination of Nitrogen in soil sample.
3. Determination of Phosphorous in soil sample.
4. Determination of Sodium and Potassium in soil sample.
5. Determination of Oil & Grease in water sample.
8. Preparation and Standardization of Standard Solutions:
   Sodium hydroxide, Potassium permanganate, Iodine, Sodium thiosulphate

Earth Science & Geology, Environmental Microbiology
9. Study of physical properties of minerals.
10. Calculation of map distance using a ratio scale.
11. Calculation of earthquake travel times.
12. Creation of topographic map with open source Q-Gis.
13. Isolation of bacteria from extreme environments (Halophiles, Alkalophiles).
15. Screening of symbiotic and non-symbiotic nitrogen fixing bacteria.
16. Screening of hydrocarbon and pesticide degrading bacteria.
SECOND SEMESTER

Ens: 201 Water and Wastewater Management

Total Hours: 48

1. Water Management 12 Hours
   1.1 Sources & intake structure of water
   1.2 Water demand & factors affecting it
   1.3 Population projection
   1.4 Flow rates and their fluctuations

2. Municipal Water Supply System 12 Hours
   2.1 Drinking water quality standards (BIS & WHO)
   2.2 Layout of drinking water treatment plant
   2.3 Water treatment processes (physical & chemical)
   2.4 Advanced water treatment processes (physical & chemical)

3. Waste Water Management 12 Hours
   3.1 Sewage characteristics & discharge standards
   3.2 Layout of sewage treatment plant
   3.3 Waste water treatment: physical, chemical and biological processes
   3.4 Sludge & septage treatment & disposal
   3.5 Wastewater disposal into natural water bodies
   3.6 Wastewater disposal on land & land application

4. Wastewater Reuse 12 Hours
   4.1 Introduction to wastewater reuse
   4.2 Municipal reuse
   4.3 Agricultural reuse
   4.4 Recreational reuse
   4.5 Ground water recharge

References
SECOND SEMESTER

Ens: 202 Advances in Environmental Biotechnology
Total Hours: 48

1. Techniques in Genetic Engineering 12 Hours
1.1 Restriction endonucleases and gene cloning
1.2 PCR, Site directed mutagenesis and nucleic acid hybridization
1.3 Plasmids and rDNA technology
1.4 Introduction to metagenome and metaproteome
1.5 Herbicide and stress tolerant plants- Bt Cotton, Golden Rice

2. Biotechnology in Pollution Abatement 12 Hours
2.1 Practical applications in pollution control: biofilter, biotrcklingfilter, bioscrubber
2.2 Production of enzymes like cellulase, proteases amylases in varied environmental conditions
2.3 Bioenergy – bioethanol production, biodiesel and biofuels
2.4 Biotechnological approaches for solid waste management, vermicomposting

3. Ecotoxicology 12 Hours
3.1 Ecotoxicology: introduction and importance
3.2 Drug dosage- ED50 and LD50
3.3 Drug metabolism and role of cytochrome p450 enzymes
3.4 Carcinogens and carcinogenicity
3.5 Bioaccumulation and biomagnification

4. Biodiversity Conservation 12 Hours
4.1 Concepts, significance, magnitude and distribution
4.2 Methods for monitoring biodiversity trends
4.3 In situ biodiversity conservation strategies and approaches: protected areas, biosphere resource, protected areas in India – sanctuaries, national parks and biosphere resources.
4.4 Ex situ biodiversity conservation: species management plans, captive breeding, field gene banks, seed gene banks, cryopreservation, gene banks
4.5 National and international efforts for biodiversity conservation: CITES, Ramsar convention, convention on biological diversity
References

SECOND SEMESTER

Ens: 203 Environmental Informatics & Statistics

Total Hours: 48

1. Ecosystem Modeling
1.1 Concept of models and ecosystem modeling
1.2 Model classification- deterministic models, stochastic models, steady state models, dynamic models
1.3 Different stages involved in model building
1.4 Ecoinformatics applications in natural resources management

2. Analytical Models in Ecology
2.1 Ecological models- characteristics and applications
2.2 Logistic model of population growth
2.3 Hardy- Weinberg model of population equilibrium
2.4 Lotka - Volterra model of competition and predation
2.5 Models of succession

3. Environmental Statistics
3.1 Measures of central tendency – mean, median, mode, geometric mean and harmonic mean
3.2 Standard deviation and standard error
3.3 Variance skewness and kurtosis
3.4 Basic laws of probability
3.5 Binominal, poison and normal distributions

4. Tests of Hypothesis
4.1 Chi Square test
4.2 T and F test
4.3 ANOVA
4.4 Correlation and linear regression of one independent variable

References
SECOND SEMESTER
Ens: 204 Instrumentation in Environmental Analysis - I
Total Hours: 48

1. **UV-Visible Spectroscopy**  
   1.1 Characteristics of electromagnetic spectrum  
   1.2 Origin of spectra and electronics transitions  
   1.3 Laws of absorption of radiation - Lambert & Beer’s law and its deviation  
   1.4 The architecture of a spectrophotometer  
   1.5 Calibration curve and standard addition method - multi component analysis  
   1.6 Applications of UV-visible spectroscopy

2. **Atomic Absorption Spectrometry**  
   2.1 The history & principle of atomic absorption spectroscopy  
   2.2 AAS – Instrumentation  
   2.2.1 Radiation sources: line & continuum  
   2.2.2 Atomization techniques: FAAS & GFAAS  
   2.2.3 Wavelength selector: monochromator  
   2.2.4 Detectors: PMT  
   2.2.5 Single & double beam AAS  
   2.5 Applications of atomic absorption spectrometry

3. **Optical Emission Spectrometry**  
   3.1 Introduction and principle  
   3.2 Atomic spectroscopic sources  
   3.3 Inductively coupled plasma - the discharge  
   3.4 ICP-OES Instrumentation  
   3.4.1 Nebulizers  
   3.4.2 Spray Chambers  
   3.4.3 Sample introduction systems  
   3.4.4 Optics and the spectrometer  
   3.4.5 Emission detectors  
   3.5 Applications of ICP-OES

4. **Advanced Instrumentation Techniques**  
   4.1 Non dispersive IR (gas analyzer)  
   4.2 Modern elemental analyzer  
   4.3 Total organic carbon analyzer  
   4.4 Principle and applications of  
   Florescence, Phosphorescence, Chemiluminescence, Turbidimetry and Naphelometry
References
SECOND SEMESTER
Ens.: 205 Practicals

Water and Wastewater Management, Instrumentation in Environmental Analysis - I

1. Determination of Total Hardness - Calcium and Magnesium in drinking water.
2. Determination of TDS, TSS & TS in drinking water.
3. Determination of Alkalinity and Acidity in drinking water.
4. Determination of BOD of sewage water.
5. Determination of Sludge volume index of sewage sludge.
6. Determination of Copper & Manganese in water sample by Spectrophotometer.

Advances In Environmental Biotechnology, Environmental Informatics & Statistics

9. Isolation and identification of microorganisms from soil rhizosphere.
10. Extraction and estimation of prokaryotic and eukaryotic organism by chemical method.
11. Isolation of cellulose, amylase and protease producing microorganisms.
12. Determination of chloroplasts per unit area, Estimation of chlorophyll content.
13. Determination of Air Pollution Tolerance Index.
   (https://bradduthie.shinyapps.io/EcoEdu/)
15. Experimental demonstration of HW law.
16. Data representation, tabulation and graphs. Find out mean, median and mode.
17. ANOVA and Chi Square Tests.