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

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	Exam Hours :3 External Marks	Internal Marks	Total Marks	Credit
Ens. 101	Earth Science & Geology	4	-	70	30	100	4
Ens. 102	Environmental Chemistry	4	-	70	30	100	4
Ens. 103	Environmental Microbiology	4	-	70	30	100	4
Ens. 104	Analytical Techniques	4	-	70	30	100	4
Ens. 105	Laboratory/Practical	-	16	140	60	200	8
Total		**16**	**16**	**420**	**180**	**600**	**24**

SECOND SEMESTER

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	Exam Hours :3 External Marks	Internal Marks	Total Marks	Credit
Ens. 201	Water and Wastewater Management	4	-	70	30	100	4
Ens. 202	Advances in Environmental Biotechnology	4	-	70	30	100	4
Ens. 203	Environmental Informatics & Statistics	4	-	70	30	100	4
Ens. 204	Instrumentation in Environmental Analysis - I	4	-	70	30	100	4
Ens. 205	Laboratory/Practical	-	16	140	60	200	8
Total		**16**	**16**	**420**	**180**	**600**	**24**

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 out side

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

1. Environmental Geology, Barbara W. Murck, B.J. Skinner, S.C. Porter, 1st Edition, 1997, John Wiley & Sons Publication.
2. Introduction to Environmental Geology, E.A. Keller, 5th Edition, 2012, Pearson Edition.
3. Geoecology: An Evolutionary Approach, R.J.Huggett, 1st Edition, 2001, Routledge publisher.
4. Introduction to Geochemistry: Principles and Applications, K. C. Misra, 1st Edition, 2012, Wiley-blackwell publisher.
5. Remote Sensing and GIS, 2nd Edition, Basudeb Bhatt, Oxford University press.
6. Basics of Remote Sensing and GIS, 1st Edition, 2014, S. Kumar, University Science Press.

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 H_2O - 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

1. Environmental Chemistry, S. C. Bhatia, 1st Edition, 2002, 7th Reprint, 2013, CBS Publishers & Distributors Pvt. Ltd.
2. Environmental Chemistry, Stanley E. Manahan, 10th Edition, 2017, CRC Press.
3. Environmental Chemistry, A. K. DE, 6th Edition, 1st Reprint, 2008, New Age International (P) Ltd., Publishers.
4. Environmental Chemistry, H. Kaur, 9th Edition, 2015, Pragati Prakashan.
5. Principles of Environmental Chemistry, James E. Girard, 3rd Edition, 1st Indian Edition 2015, Jones and Barrlett India Pvt. Ltd.
6. Environmental Chemistry, B.K. Sharma, 16th Edition, 2016, Goel Publishing House.

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

1. Environmental Microbiology: From Genomes to Biogeochemistry, Eugene L. Madsen, 1st Edition, 2008, Blackwell Publishing.
2. The Physiology and Biochemistry of Prokaryotes, David White, 2nd Edition, 2003, Oxford University Press.
3. Microbial Physiology, Albert G. Moat, John W. Foster, Michael P. Spector, 4th Edition, 2009, Wiley.
4. Sulfide-Containing Environments, Encyclopedia of Microbiology, Rutger de Wit, Lederberg Joshua, Vol-.4, 2nd Edition, 2000, Academic Press.
5. Bacterial Physiology and Metabolism, Byung Hong Kim and Geoffrey Michael Gadd, 1st Edition, 2008, Cambridge University Press
6. Biodegradation and Bioremediation, Alexander, M., 2nd Edition, 1999, Academic Press.
7 Molecular Microbial Ecology (Advanced methods), Osborn, A. & Smith, C., 1st Edition, 2005, BIOS Scientific Publisher.
8. Manual of Environmental Microbiology, Hurst, C. 3rd Edition, 2007, ASM Press.
9. Introduction to Biodeterioration, Allsopp, D.et. al., 2nd Edition, 2004, Cambridge University Press.
10. Bergey's Manual of Systematic Bacteriology, Garrity, G. M. and Boone, D. R., Volume 1-5; 2nd Edition, 2001, Springer.

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 Gibbs free energy & chemical potential
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: Cl^- & 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:

1. Chemistry for Environmental Engineering and Science, C. N. Sawyer and P. L. Mc Carty, G.F. Parkin, 5th Edition, 21st Reprint, 2015, McGraw Hill Education (India) Private Limited.
2. Environmental Chemistry, H. Kaur, 8th Edition, Reprint 2014, Pragati Prakashan.
3. Quantitative Analysis, R.A Day, A.L Underwood, 6th Edition, 1991, Prentice-Hall.
4. Standard Methods for Examination of Water & Wastewater – Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
5. Environmental Chemistry - A. K. De, 7rd Edition, 2015, New Age international (P) Ltd.
6. Official Methods of Analysis – Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
7. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, 9th Edition, Reprint 2014, Cengage Learning.
8. Analytical Instrumentation, Bela G. Liptak, 1st Edition,1994, 1st Indian Reprint, 2012, Chilton Book Company.

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.
6. Determination of Free Residual Chlorine in water sample.
7. Determination of Iron 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).
14. Isolation of moderate thermophiles from arid and semiarid environments.
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

1. Municipal Water & Waste Water Treatment, Rakesh Kumar & R. N. Singh, 1st Edition, Third reprint, 2014, TERI Press Publisher.
2. Wastewater Treatment for Pollution Control and Reuse, Soli J. Aarsivala & Shyam R. Asolekar, 3rd Edition, 12th Reprint, 2016, McGraw Hill Education (India) Pvt. Ltd.
3. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Inc., 4th Edition, 27th Reprint, 2015, McGraw Hill Education (India) Pvt. Ltd.
4. Water Supply and Sanitary Engineering, G. S. Birdie & J. S. Birdie, 7th Edition, 2017, Dhanpatrai Publishing Company.
5. Water Resource Augmentation, Management & Policies, H. Sarvothaman, 1st Edition 2004, Asiatech Publishers Inc.

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, biotricklingfilter, 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
4.5National and international efforts for biodiversity conservation: CITES, Ramsar convention, convention on biological diversity

References

1. Ecology, Environment and Resource Conservation. Singh, J.S., Singh, S.P. and Gupta, S.R., 1st Edition, 2015, S. Chand Publishing.
2. Environmental Biotechnology: Theory and Application, Evans, G.M. and Furlong J.C., 2nd Edition, 2003, John Wiley and Sons.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Glick, B.R. and Pasternak J.J., 4th Edition, 2007, ASN Press.
4. Introduction to Environmental Biotechnology, Chatterjee A.K., 3rd Edition, 2011, Prentice Hall of India Private Ltd.
5. Fundamentals of Environmental and Toxicological Chemistry: Sustainable Sciences, Stanley E. Manahan, 4th Edition, 2013, CRC Press.
6. Environmental Biotechnology: Basic Concepts and Applications - I. S. Thakur, 1st Edition, 2006, IK International Publications.
7. Environmental Biotechnology, M. H. Fulekar, 1st Edition, 2010, Science Publishers.
8. Principles of Gene Manipulation and Genomics, S. B. Primrose and R. Twyman, 7th Edition, 2009, Blackwell Publishing.
9. Genetic Engineering: Principles and Practice, S. Mitra, 2nd Edition, 2015, McGraw Hill Education (India) Private Limited.

SECOND SEMESTER

Ens: 203 Environmental Informatics & Statistics

Total Hours: 48

1. Ecosystem Modeling **12 Hours**

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 **12 Hours**

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 **12 Hours**

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 **12 Hours**

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

1. Environmental Modelling - An Introduction., Jo Smith and Pete Smith, 1st Edition, 2007, Oxford University Press.
2. Models in Ecology, John Maynard Smith, 1st Edition (Revised), 2010, Cambridge University Press.
3. Fundamentals of Statistics, Gupta S.C., 6th Edition, 2011, Himalaya Publishing House.
4. Fundamentals of Mathematical Statistics, Gupta S.C. and Kapoor V.K., 10th Edition (Revised), 2002, Sultan Chand and Sons.
5. Statistical Methods for Environmental and Agricultural Sciences, Hoshmand, A.R., 2nd Edition, 1998, CRP Press.
6. Environmental Modeling: Finding Simplicity in Complexity, John, W. and Mark, M. 2nd Edition, 2013, John Wiley and Sons Inc.

SECOND SEMESTER

Ens: 204 Instrumentation in Environmental Analysis - I

Total Hours: 48

1. UV-Visible Spectroscopy **12 Hours**

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 **12 Hours**

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 **12 Hours**

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 **12 Hours**

Principle, Instrumental set up & Applications of
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

1. Engineering Chemistry, P.C. Jain & Monica Jain, 17th Edition, Reprint 2011, Dhanpatrai Publishing Company (P) Ltd.
2. Handbook of Analytical Instrument, R.S. Khandpur,2nd Edition, Reprint 2009, Tata McGraw Hill Publishers.
3. Instrumental Methods of Chemical Analysis(Analytical Chemistry) , H. Kaur, 8th Edition, 2012, Pragati Prakashan.
4. Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, Reprint 2009, New Age International (P) Limited, Publishers.
5. Analytical Instrumentation Handbook, Ewing's , Edited by Jack Cazes, 3rd Edition, 2005, Marcel Dekker Publisher.
6. Instrumental Methods of Analysis, H.H.Willard, L.L.Meritt, J.A. Dean and F.A. Settle, 7th Edition,1986, CBS Publishers.
7. Instrumental methods of analysis, B.K. Sharma, 24th Edition, 2005, Goel Publishing House.
8. Instrumental Analysis, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, 11th Edition, Reprint 2012, Cengage Learning.

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.
7. Determination of Phenol & COD in water sample by Spectrophotometer.
8. Determination of Anionic Surfactant & Silica 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.
14. Simulation model for predator-prey interactions. (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.