GUJARAT VIDYAPITH : AHMEDABAD  
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar  
Department of Biogas Research and Microbiology  
M.Sc. (Environmental Sciences and Technology) (By Research)  
Course Structure  
(Duration- Four Semesters, Total Credit= 93)

First Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory +/- Practicals</th>
<th>Credit (Theory +/Practicals)</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EST-101</td>
<td>Research Methodology and Scientific Writing</td>
<td>T</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>EST-102</td>
<td>Statistical Techniques and Computer Applications</td>
<td>T+P</td>
<td>4+2</td>
<td>120</td>
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<tr>
<td>EST-103</td>
<td>Eco-technology</td>
<td>T+P</td>
<td>4+2</td>
<td>120</td>
</tr>
<tr>
<td>EST-104</td>
<td>Environmental Pollution</td>
<td>T+P</td>
<td>4+2</td>
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<tr>
<td>FC-101</td>
<td>Gandhian Thoughts</td>
<td>T</td>
<td>2</td>
<td>30</td>
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<tr>
<td>COMPL-101</td>
<td>Padyatra</td>
<td>P</td>
<td>2</td>
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<tr>
<td>COMPL-102</td>
<td>Udyog</td>
<td>P</td>
<td>2</td>
<td>45</td>
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<tr>
<td><strong>Total Credits</strong></td>
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<td></td>
<td><strong>18+10= 28</strong></td>
<td><strong>495</strong></td>
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FC= Fundamental Course  
COMPL= Compulsory Course

Second Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory +/- Practicals</th>
<th>Credit (Theory +/Practicals)</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>EST-201</td>
<td>Advance Analytical Techniques for Environmental Sciences</td>
<td>T+P</td>
<td>4+2</td>
<td>120</td>
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<tr>
<td>EST-202</td>
<td>Industrial Pollution and Control Technology</td>
<td>T+P</td>
<td>4+2</td>
<td>120</td>
</tr>
<tr>
<td>EST-203</td>
<td>Research- Part-I</td>
<td>P</td>
<td>5</td>
<td>150</td>
</tr>
<tr>
<td>EC-201</td>
<td>Seminar and Field Visit</td>
<td>P</td>
<td>2</td>
<td>60</td>
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<tr>
<td>COMPL-202</td>
<td>Udyog</td>
<td>P</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
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<td><strong>8+13=21</strong></td>
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## Third Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory +/Practicals</th>
<th>Credit (Theory +/-Practicals)</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>EST-301</td>
<td>Environmental Biotechnology</td>
<td>T+P</td>
<td>4+2</td>
<td>60+60=120</td>
</tr>
<tr>
<td>EST-302</td>
<td>Environmental Chemistry</td>
<td>T+P</td>
<td>4+2</td>
<td>60+60=120</td>
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<tr>
<td>EST-303</td>
<td>Research- Part-II</td>
<td>P</td>
<td>5</td>
<td>150</td>
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<tr>
<td>EC-301</td>
<td>Seminar and Field Visit</td>
<td>P</td>
<td>2</td>
<td>60</td>
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<tr>
<td>COMPL-301</td>
<td>Padyatra</td>
<td>P</td>
<td>2</td>
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<td>COMPL-302</td>
<td>Udyog</td>
<td>P</td>
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<td><strong>Total Credits</strong></td>
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<td><strong>8+15=23</strong></td>
<td><strong>495</strong></td>
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## Fourth Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory +/Practicals</th>
<th>Credit (Theory +/-Practicals)</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EST-401</td>
<td>Sustainable Development</td>
<td>T+P</td>
<td>4+2</td>
<td>60+60=120</td>
</tr>
<tr>
<td>EST-402</td>
<td>Environmental Management</td>
<td>T+P</td>
<td>4+2</td>
<td>60+60=120</td>
</tr>
<tr>
<td>EST-403</td>
<td>Research- Part-III</td>
<td>P</td>
<td>5</td>
<td>150</td>
</tr>
<tr>
<td>EC-401</td>
<td>Presentation of Research Work in seminar/ symposium/ conference</td>
<td>P</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>COMPL-402</td>
<td>Udyog</td>
<td>P</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td></td>
<td><strong>8+13=21</strong></td>
<td><strong>495</strong></td>
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<table>
<thead>
<tr>
<th>Semester</th>
<th>Credit</th>
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<tbody>
<tr>
<td>First</td>
<td>28</td>
</tr>
<tr>
<td>Second</td>
<td>21</td>
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<tr>
<td>Third</td>
<td>23</td>
</tr>
<tr>
<td>Fourth</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>93</strong></td>
</tr>
</tbody>
</table>

For Theory= 1 credit is equal to 15 Hours  
For Practical= 1 credit is equal to 30 Hours
Objectives:

- To verify and test important facts
- To analyse an event or process or phenomenon to identify the cause and effect relationship
- To develop new scientific tools, concepts and theories to solve and understand scientific problems.
- To find solutions to scientific.
- To overcome or solve the problems occurring in our everyday life.
- To Introduce The Concept of Scientific Research And The Methods of Conducting Scientific Enquiry

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Research Methodology (15 Hrs)</td>
</tr>
<tr>
<td></td>
<td>1. Research methodology: An Introduction: Creativity, innovation, originality and advancement of knowledge and application to the society</td>
</tr>
<tr>
<td></td>
<td>2. Define the research problem</td>
</tr>
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<td></td>
<td>3. Methods of Research</td>
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<td>4. Ethics in research</td>
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<tr>
<td>2</td>
<td>Research Design (15 Hrs)</td>
</tr>
<tr>
<td></td>
<td>1. Meaning and Objectives,</td>
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<tr>
<td></td>
<td>2. Characteristics of good research design.</td>
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<tr>
<td></td>
<td>3. Components of the research design.</td>
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<td></td>
<td>4. Review of literature.</td>
</tr>
<tr>
<td>3</td>
<td>Research Project and Research Proposals (15 Hrs)</td>
</tr>
<tr>
<td></td>
<td>1. Selecting a Research Topic.</td>
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<td>2. Project Planning.</td>
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<td></td>
<td>3. Identifying funding sources and special founding mechanisms.</td>
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<tr>
<td></td>
<td>4. Writing a Proposal.</td>
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<tr>
<td></td>
<td>5. Research Ethics and Responsibilities.</td>
</tr>
<tr>
<td>4</td>
<td>Scientific Writing (From Research to Manuscript) (15 Hrs)</td>
</tr>
<tr>
<td></td>
<td>1. Tools and Techniques.</td>
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<tr>
<td></td>
<td>2. The Scientific Paper.</td>
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<tr>
<td></td>
<td>3. Scientific writing skills.</td>
</tr>
<tr>
<td></td>
<td>4. Preparing to Publish.</td>
</tr>
</tbody>
</table>
References: EST: 101: Research Methodology


GUJARAT VIDYAPITH : AHMEDABAD  
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-I  
EST-102 Statistical Techniques and Computer Applications  
(Syllabus of theoretical portion) (In force from June, 2017)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=60, Credit=04)

Learning outcomes:
• Student will learn to collect data for statistical analysis.
• Student will learn to apply various statistical measures.
• Student will learn fundamentals of computer and bioinformatics.

Unit-I Basics of statistics (15 hours)
Introduction to Statistics; (2 hours)
Collection, classification and tabulation of data (8 hours)
Frequency distribution (5 hours)

Unit-II Statistical measures (15 hours)
Measures of location- Arithmetic mean, median and mode (5 hours)
Measures of dispersion- Range, standard deviation, coefficient of variation, skewness, kurtosis (10 hours)

Unit-III Statistical analytical techniques (15 hours)
Tests of hypotheses (3 hours)
Correlation and Regression (5 hours)
Probability - normal, poisson and binomial (5 hours)
Time series analysis (2 hours)

Unit-IV Bioinformatics and computers (15 hours)
Bioinformatics and its applications (5 hours)
Computer- classification, functional blocks of computer hardware, input & output devices, application of computers (10 hours)

References and suggested readings:
3. Textbook of Computer applications and biostatistics- ebook, Dr. S. B. Bhise, Dr. R. J. Dias, K. K. Mali and P. H. Ghanwat, Trinity publishing house, Satara
4. Modeling Tools for Environmental Engineers and Scientists, by N. Nirmala Khandan, CRC PRESS
Learning outcomes:

• Student will learn various technologies available for sustainable development of villages.
• Student will learn various techniques to be used for rural cleanliness.
• Student will learn various techniques available to restore degraded eco-system.
• Student will learn the concept of Eco-village.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Eco-Technology</td>
<td>(15 hours)</td>
</tr>
<tr>
<td></td>
<td>Ecotechnology: Definition, concept and perspective, Eco-designing, Ecotechnology for social welfare and sustainable development. Ecotechnology for rural development. Selection of appropriate technology for rural environment: Biogas technology for rural environment, community biogas plants; Bioenergy, Agro chemicals, Biological Control measures.</td>
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</tr>
<tr>
<td>2</td>
<td>Eco technology in cleaner production</td>
<td>(15 hours)</td>
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<tr>
<td>3</td>
<td>Eco-technological restoration</td>
<td>(15 hours)</td>
</tr>
<tr>
<td></td>
<td>Concept and importance of SPS (Sanitary and Phytosanitary), WTO-SPS agreement, sanitation and phytosanitation technology Green inhibitor: Environmental green inhibitor. Eco system dynamics: Restoration of degraded eco system using ecological approach, wasteland, mining area, building resilience, Ecological resilience, soil fertility management; water resource management.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Eco Village Development</td>
<td>(15 hours)</td>
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<tr>
<td></td>
<td>Transfer of technology from lab to land: Barren land reclamation using Mycorrhiza, solid waste management, development of compost, vermi compost and Bio energy, Solar based technology for water purification, Pesticides remediation using rhizosphere technology, Phytostabilization of contaminants, Water harvesting, Pond water reservoir, Microalgae based energy generation, Eco plantation.</td>
<td></td>
</tr>
</tbody>
</table>
References
Learning outcomes:
- Student will be able to analyse biogas slurry, compost and soil for its nutrients content.
- Student will be able to enhance their practical skill.
- Student will learn to calculate and interpret the results.
- Students will be able to find out microbial populations in soil and compost.

Practicals:

1. Standard Plate Count (SPC) of pristine and contaminated soil samples.
2. Seed germination test of untreated and treated wastewater.
4. Estimation of nitrogen content from biogas slurry by kjeldahl method.
5. Measurement of Total Volatile Fatty acid from inlet and outlet of biogas plant.
6. Analysis of moisture content from compost.
7. Find out Total fungal count (TFC), Total Yeast Count (TYC), Total Actinomycetes Count (TAC) and Total Azotobacter Count (TAC) from compost sample.
8. Methane measurement from biogas slurry by orset apparatus. (Demo practical)
Learning outcomes:
• Student will learn various types of pollution.
• Student will learn the impact of various types of pollution on health of living beings.
• Student will learn various techniques used to control these pollution.

Unit-1: Air Pollution (15 hours)
1.1 Definition (1 hour)
1.2 Natural sources of air pollution (1 hour)
1.3 Human caused air pollution (1 hour)
1.4 Classification of air pollutants (1 hour)
1.5 Transport and diffusion of pollutants (1 hour)
1.6 Effect of air pollutants on human health, plants, animals, microbes and materials. (3 hours)
1.7 Air pollution episodes: Bhopal, Chernobyl, Los Angeles, London smog, Indonesian forest fire (2 hours)
1.8 Acid rain (1 hour)
1.9 Ozone depletion (1 hour)
1.10 Global Warming and climate changes (1 hour)
1.11 Air Pollution Control (2 hours)

Unit-2: Water Pollution (15 hours)
2.1 Definition (1 hour)
2.2 Types of water pollution (1 hour)
2.3 Effect of water pollution (1 hour)
2.4 Physico-chemical and microbial characteristics of domestic, industrial and agricultural waste water. (3 hours)
2.5 River pollution (1 hour)
2.6 Marine pollution (1 hour)
2.7 Drinking and irrigation water quality parameters: Criteria and standards (2 hours)
   - Municipal water treatment (1 hour)
   - Treatment of water for Industrial use (1 hour)
2.8 Water pollution control (3 hours)

Unit-3: Soil Pollution (15 hours)
3.1 Definition (1 hour)
3.2 Sources and types of soil pollution (2 hours)
   - Impact of usage of land for solid waste disposal of both municipal solid waste and industrial solid waste (1 hour)
   - Disposal of hazardous solid waste (heavy metals, toxic organic compounds) on land and its impact on soil pollution (1 hour)
   - Deterioration of soil due to mining activities (1 hour)
3.3 Physico-chemical and microbial characteristics of soil pollutants (3 hours)
3.4 Adverse effect of soil pollutants (2 hours)
3.5 Remedial measures of soil pollution (2 hours)

Unit-4: Noise and Radioactive Pollution (15 hours)
4.1 Characteristics of sound wave (1 hour)
4.2 Sources of noise pollution (2 hours)
4.3 Measurement of noise level and indices (1 hour)
4.4 Noise exposure levels and standards (1 hour)
4.5 Noise control and abatement measures (1 hour)
4.6 Sound pressure level (1 hour)
4.7 Noise-spectra-octave bands (1 hour)
4.8 Combining decibels (1 hour)
4.9 Impact of noise pollution on human health (1 hour)
4.10 Types, sources and consequences of radioactive pollution (1 hour)
4.11 Models of radioactive decay (1 hour)
4.12 Radioactive exposure to human and environment (1 hour)
4.13 Remedial Measures (2 hours)

Reference books

Learning outcomes-
• Students will be able to find out potability of water.
• Students will be able to analyse air, water and soil samples for its various parameters.
• Students will be able to enhance their hands-on-practice of analysis.

1. Estimation of the amount of oxides of sulphur in the ambient air (10 hours)
2. Estimation of the amount of oxides of nitrogen in the ambient air (10 hours)
3. Physico -chemical characterization of ground water and comparison with drinking and irrigation standards (20 hours)
4. Measurement of noise level in industrial and residential area (10 hours)
5. Determination of pH, electrical conductivity and organic matter in soil (10 hours)
Learning Outcomes:
• Students will study about various analytical techniques for Environmental studies.
• Students will learn about sampling, preservation and analysis of various environmental samples.
• Students will learn the operating principles of various instruments used for Environmental studies.

Objectives:
Environmental analysis has evolved from the traditional analytical chemistry to a well-established discipline and a profession attractive to a diverse group of environmental scientists / engineers, chemists, and educators. Environmental analysis and monitoring is a very challenging and dynamic field in a sense that it involves the most uncertain and error-prone stage of acquiring representative samples, laborious sample preparation from complex matrices, costly instrumental qualification and quantification of contaminants at the parts per million to parts per quadrillion levels, and the ever changing requirements for regulatory compliance in monitoring drinking water, wastewater, ambient / emission air, and solid / hazardous wastes. The discussions of this chapter start with the historical perspectives, unique features, and scopes of this discipline. The importance of representative sampling, the approaches to select cost effective sampling design schemes, as well as classical grab / active sampling vs. passive diffusion-based sampling techniques are delineated, followed by the discussions of environmental sample preparation goals, various digestion procedures for inorganic metals, and various extraction and partition based methods for volatile and semi-volatile compounds. Traditional chemical instrumental methods and their corresponding environmental applications are briefly described with respect to spectroscopic, chromatographic, mass spectrometric, electrochemical, thermal, and radiological methods. Complementary bioanalytical methods currently used in environmental analysis such as immunoassays and those with promise in future development such as biosensors are introduced. This chapter concludes with the remarks on the future perspectives and challenges of environmental analytical chemistry. There is an urgent need for advancing sampling methodology for practical applications, instrumental innovations for faster, more sensitive and affordable bench instruments, and miniature sensing devices for real-time monitoring and remote applications.
### Unit 1: Environmental Monitoring (15 Hrs)

1. **Concepts** of environmental monitoring and its significance.
2. **Methods** of physical characterization of samples.
3. **Sampling** of air, water and soil: Protocol and methods of sampling, sampling devices, preservation, storage and processing of air, water and soil samples.

### Unit 2: Advance Instrumentation Methods (15 Hrs)

1. **Fundamental of Basic Instruments**: Concept, Electromagnetic spectrum Infrared Spectroscopy, Flame emission Spectroscopy and Atomic absorption spectroscopy.

### Instrumental Methods Separation Techniques: 1: (15 Hrs)

1. **Chromatography**: Paper; TLC; Conventional Column Chromatography- Ion-Exchange; Affinit.
2. **Specialized Technique-I**: GLC-Column; Detectors. HPLC: Pumps; Columns; Instrumentation.
3. **Specialized Technique-II**: HPTLC

### Instrumental Methods Separation Techniques: 2: (15 Hrs)

1. **Centrifugation Techniques**: Types of centrifugation; Rate Zone; Isopycnic; High speed; Ultra; preparative; Gradient.
2. **Electrophoretic Techniques**: Native, SDS, Agarose and 2D; Zone EP; Isoelectric; Slab Gel; DISC EP; Immuno EP; Pulsed Field; Cellular Gel EP.

### References:

1. Instrumental methods of chemical analysis. *Sharma B.K.*
2. Instrumental methods of analysis. *Skoog D.A.*
Learning Outcomes:
• Students will be able to analyse various environmental samples.
• Students will learn to operate various instruments used for Environmental studies.
• Students will learn techniques of analysis of various environmental samples.
• Through visits students will be able to enhance their vision about various analytical techniques used by Industries for study of Environmental samples.

1. Determination of organic contaminant/pollutant in environmental samples: UV-Visible spectrophotometer/HPLC/HPTLC/GLS.
2. Determination of heavy metals in environmental samples by spectrophotometer/AAS.
3. Separation of amino acids by using paper & TLC chromatography
4. Demonstration of instruments for analysis of environmental samples.
5. Determination of wind velocity by anemometer, atmospheric pressure by aneroid barometer, temperature by minimum and maximum thermometer, relative humidity by wet and dry thermometer, sunshine hour by sunshine recorder.
6. Preparation of acids and alkali of particular materials.
7. Preparation of uniform acid solutions.
8. Visit to Meteorological Department, Ahmedabad, Gandhinagar.
9. Visit to Specialised Instrumental Laboratory: SICART, iSTAR-VV Nagar, NFDD-Rajkot
GUJARAT VIDYAPITH: SADRA
SUBJECT: ENVIRONMENTAL SCIENCES AND TECHNOLOGY
EST 202: Industrial Pollution and Control Technology
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Learning Outcomes:
• Students will learn about various characteristics of Domestic and Industrial waste-water.
• Students will learn the CETP-concept of waste water treatments.
• Students will learn Biological treatment process in detail.
• Students will be sensitized about various types of pollution.

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<thead>
<tr>
<th>Unit</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Scenario of Industrial wastewater</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Types of industrial wastewater, definition of wastewater, Constituents in wastewater, Sources of domestic and industrial wastewater, Chemical and microbiological characteristics, BOD, COD and TOC as indicator of strength of waste water, Pollution problems due to disposal of untreated wastewater. Domestic Wastewater-Define: Septage, Sewage, Fluctuation in generation of domestic wastewater and their quality. Characteristics of Domestic wastewater, Wastewater collection point, Types of sewers, Types of sewage systems, House Hold Drainage System-Traps, Inception chambers, Manholes, Waste collection pipes, primary and secondary clarifiers, activated sludge plant and trickling filter units, Low cost sanitation systems, soak pit, stabilization ponds.</td>
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<tr>
<td>2</td>
<td>Wastewater unit operation</td>
<td>15 Hrs</td>
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<tr>
<td></td>
<td>CETP-concept, objectives, advantages and disadvantages and ownership. Physical unit operation, Chemical unit operation, Biological unit operation- Introduction to Biological Treatment: Role of microorganisms, types of biological processes for wastewater treatment, Disposal standards, Disposal of effluents (Land, water bodies). Residual (sludge) Management: Residuals of industrial wastewater treatment- Quantification and characteristics, treatment and disposal- Thickening, Digestion, Conditioning, Dewatering and Disposal.</td>
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<tr>
<td>3</td>
<td>Treatments of industrial effluents</td>
<td>15 Hrs</td>
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<td>Origin (Manufacturing process) and characterization, standards of industrial wastewater and common and specialized methods for treatment of industrial effluents of -Pharmaceuticals, Textile, Paper and Pulp Dairy industries. primary treatment, Secondary treatment(biological), Principles, Role of microorganisms in; septic tank, Imhoff tank, trickling filters, activated sludge process, oxidation pond methods. Advanced treatment and final treatment Noise Pollution: Acoustical concepts, Sources, Measuring instruments and techniques, Health effects, Traffic Noise Index (TNI), Noise pollution level (NPL), Sound exposure level Noise standards and limits, Noise control methods (source, path and receiver end)</td>
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</table>
4 Radioactive Pollution

Types of radiation, Radiation units, Types of radioactive materials, Radiation sources (natural, commercial and industrial) effects and radiation protection. Radiation interaction with biological materials: Nucleic acids (DNA & RNA), Proteins, Carbohydrates, Lipids and membranes. Thermal pollution: Sources, effects, Control and prevention

References:

GUJARAT VIDYAPITH: SADRA
SUBJECT: ENVIRONMENTAL SCIENCES AND TECHNOLOGY
EST 202: Industrial Pollution and Control Technology (Practicals)
THEORY: 60 Hrs. CREDIT: 02: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)
(Effective from June 2017)

Learning Outcomes:
• Students will learn characterize waste-water for its various parameters.
• Students will learn analytical techniques to find out concentration of various heavy metals
  in waste water.
• Students will learn to evaluate Noise pollution.
• Students will be educated about treatment of pollution through visit of CETP.

Practicals
1. Characterization of wastewater – Sewage, Industrial effluent and receiving water body for
   physico-chemical and biological properties: pH, conductivity, colour, temperature, total
   solids, dissolved solids, suspended solids, chloride, phosphate, nitrate, sulphate, hardness,
   calcium, Magnesium, total alkalinity, oil and grease, ammonical nitrogen, phenolic
   compounds, BOD, COD, total acidity, sludge volume index, MLSS and MLVSS.
2. Determination of Iron, Chromium, Pb, Hg.
3. Measurement of Noise using SLM
4. Visit to various industry.
GUJARAT VIDYAPITH : AHMEDABAD  
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-II  
EST-203: Research Part-1  
(Syllabus of practical portion) (In force from December, 2017)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=150, Credit=05)

Learning outcomes:
• Students will learn to search related research papers.
• Students will learn to read and interpret research and review papers.
• Students will learn to write review literature along with references.

In first week of second semester Guide will be allotted to students. Student may start his/her research work from this semester but the minimum work required to evaluate in this semester would be submission of “Review of literature” by the student to Department based on his/her research topic.
Learning outcomes:
• Students will learn to prepare their presentation for seminar.
• Students will learn to prepare slides and discuss them.
• Students will learn the factual position of operation of Industries/ Research Institute through visits.

Every student shall have to deliver a Seminar on a recent topic related to Environmental Sciences as approved by the Department. Seminar will be of half an hour duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

Evaluation would be done by faculty members.

Every student shall have to participate in field visit related areas of Environmental Sciences arranged by Department. Evaluation would be based on written and oral presentation made by student against faculty members.
GUJARAT VIDYAPITH : AHMEDABAD  
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-III  
EST -301: Environmental Biotechnology  

THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)  

Learning outcomes:  
- Student will learn basic concept of Environmental Biotechnology.  
- Student will learn various Biotechnological approaches used for remediation purpose.  
- Student will learn types of wastes along with their treatment technologies.  
- Student will learn various techniques to produce Ecologically safe products

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Environmental Biotechnology: An Introduction</td>
<td>15 Hrs</td>
</tr>
<tr>
<td>2</td>
<td>Remediation Technology</td>
<td>15 Hrs</td>
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<tr>
<td>3</td>
<td>Waste Treatment</td>
<td>15 Hrs</td>
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<td>References:</td>
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<tr>
<td>1. Environmental Biotechnology- Alan Scagg, Oxford University Press.</td>
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</tr>
</tbody>
</table>

|  |  |
| 4 Ecologically safe products and processes | 15 Hrs |
Learning outcomes:
• Student will learn basic concept of Mycorrhiza development.
• Student will learn the techniques used to remove heavy metals from rhizosphere.
• Student will learn the techniques used to remove pollutant in bioreactor.

Practicals:
1. Development of Mycorrhiza soil.
2. Rhizosphere bioremediation of heavy metals.
3. Rhizophere bioremediation of HC/PAH.
GUJARAT VIDYAPITH : AHMEDABAD  
Department of Microbiology, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-III  
EST-302: Environmental Chemistry  
(Syllabus of theoretical portion) (In force from June, 2018)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=60, Credit=04)

Learning outcomes:
• Student will learn various reactions occur in environment.  
• Student will able to understand the toxicological reactions occur between various compounds.  
• Student will learn the environment friendly concept of chemistry.  
• Student will learn about nanomaterials and their applications.

Unit-1: Atmospheric Chemistry (15 hours)
1.1 Introduction (1 hour)  
1.2 Photolysis Process (2 hours)  
1.3 Chemical processes and chain reactions in the atmosphere (2 hours)  
1.4 Oxidation processes in the atmosphere (2 hours)  
1.5 Acid-base reactions in the atmosphere (1 hour)  
1.6 Ions in the atmosphere (1 hour)  
1.7 Evolution of the atmosphere (1 hour)  
1.8 Reaction of atmospheric oxygen (2 hours)  
1.9 Reaction of atmospheric nitrogen (1 hour)  
1.10 Atmospheric carbon dioxide (1 hour)  
1.11 Atmospheric water and atmospheric particles (1 hour)  

Unit-2: Toxicology and Toxicological Chemistry (15 hours)  
2.1 Introduction (1 hour)  
2.2 Synergism, Potentiation and Antagonism (1 hour)  
2.3 Dose-response relationship (1 hour)  
2.4 Relative toxicities (2 hours)  
2.5 Reversibility and sensitivity (2 hours)  
2.6 Xenobiotic and endogenous substances (1 hour)  
2.7 Toxicological chemistry (2 hours)  
2.8 Kinetic phase and dynamic phase (2 hours)  
2.9 Tetratogenesis, mutagenesis, Carcinogenesis, Immune system effects and reproductive  
Effects (2 hours)  
2.10 Health hazards (1 hour)  

Unit-3 : Green Chemistry (15 hours)  
3.1 Introduction (1 hour)  
3.2 Basic principles (twelve) of green chemistry (2 hours)  
3.3 Designing a green synthesis (4 hours)  
- Choice of starting materials
- Choice of reagents
- Choice of catalysts
- Choice of solvents

3.4 Ultrasound assisted and Microwave assisted green synthesis (2 hours)
3.5 Biocatalysts in organic synthesis (2 hours)
  - Biochemical (Microbial) oxidations
  - Biochemical (Microbial) reductions
3.6 Aqueous phase reactions (2 hours)
  - Diels-Alder reaction
  - Epoxidation
  - Reduction of carbon-carbon double bonds
  - Synthesis of polycarbonates
3.7 Green chemistry in sustainable development (2 hours)

Unit-4: Nanotechnology and Environment (15 hours)
4.1 Introduction (1 hour)
4.2 History of Nanomaterials (2 hours)
  - The Lycurgus cup
  - Michael Faraday’s colloids
  - The story of the Damascus sword
4.3 Types of nanomaterials (2 hours)
  - One dimensional materials (Single or multi walled carbon nanotubes)
  - Two dimensional materials (nanofilms, nanosheets, Nanowalls)
4.4 Synthesis of nanomaterials (3 hours)
  - Top-down approach
  - Bottom-up approach
4.5 List of Characterization techniques for nanomaterials with very specific use (2 hours)
4.6 Environmental applications of nanomaterials (5 hours)
  - Nanomembranes in Drinking water treatment,
  - Nanomembranes in Sea desalination.
  - Nanomaterial in microfuel cell, fuel Cell, hydrogen storage.
  - Nanosensors

Reference books
7. Manahan, S. E. Green chemistry and the ten commandments of sustainability,
GUJARAT VIDYAPITH : AHMEDABAD  
Department of Microbiology, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-III  
EST-302: Environmental Chemistry  
(Syllabus of practical portion) (In force from June, 2018)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=60, Credit=02)  
-----------------------------------------------------------------  
Learning outcomes:  
• Student will learn assessment of toxicity of heavy metals on seed germination.  
• Student will able to understand about synthesis of nano-materials.  
• Student will learn the environment friendly concept of chemistry by knowing the preparation and use of green natural indicator.  

1. Assessment of toxicity of heavy metals on seed germination (10 hours)  
2. Synthesis of plant based nano-materials and characterization (15 hours)  
3. Sol gel method of synthesis of nano-material and characterization (15 hours)  
4. Preparation and use of green natural acid-base indicator (5 hours)  
5. Preparation of propene by two methods can be studied (15 hours)  
   (I) Triethylamine ion + OH⁻ → propene + trimethylpropene + water  
   (II) Propan-1-ol + H₂SO₄ → propene + water
Learning outcomes:
• Student will formulate his/her research design with the guidance of respective faculty member.

The student has to present his/her Research Design against Research Advisory Committee (RAC) formulated by Department in consultation with Guide during first fortnight of semester-III. Afterword the student may continue his/her research work. The student will be evaluated based on power point presentation of his/her research work made against faculty members of Department.
GUJARAT VIDYAPITH : AHMEDABAD  
Department of Microbiology, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-III  
EC-301: Seminar and Field Visit  
(Syllabus of practical portion) (In force from June, 2018)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=60, Credit=02)

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Learning outcomes:
• Delivering seminar will develop logical thinking in student about a environment related issue.
• Student will become sensitize to surrounding environment by field visit.

Every student shall have to deliver a Seminar on a recent topic related to Environmental Sciences as approved by the Department. Seminar will be of half an hour duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

Evaluation would be done by faculty members.
Every student shall have to participate in field visit related areas of Environmental Sciences arranged by Department. Evaluation would be based on written and oral presentation made by student against faculty members.
GUJARAT VIDYAPITH : AHMEDABAD
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar
M.Sc. (Environmental Sciences and Technology) Semester-IV
EST-401 Sustainable Development
(Syllabus of theoretical portion) (In force from December, 2018)
(External Evaluation: 60% + Internal Evaluation: 40%)
(Total Teaching Hours=60, Credit=04)

Learning outcomes:
• Student will learn the concept of sustainability.
• Student will be able to understand the importance of sustainability in different areas of life like agriculture, energy etc.

UNIT I: Introduction to Sustainable Development
Concept and principles of sustainable development
Challenges towards sustainable development
Measurement strategies
Governance

Unit II: Sustainable Energy Resources
Energy, Ecology and Environment
Rural Energy Planning
Biodiesel
Nuclear Energy
Energy from Biomass

Unit III: Sustainable Agricultural Resources
Sustainable fertilizer resources for agricultural development
Sustainable measures to control pathogens of agricultural crops

Unit IV: Sustainability in other sectors
Sustainable Food and Nutrition Security
Sustainable Transport

References and suggested readings
Learning outcomes:
• Student will learn to analyse different agricultural biomass for their energy content.
• Student will learn to prepare and analyze various fertilizers.
• Student will be able to prepare Biodiesel.
• Student will learn to perform water/energy audit.

1. Energy content of different biomass.
2. Preparation and analysis of sustainable fertilizers.
3. Biodiesel
4. Develop the concept model/note for sustainable development through environment perception.
5. To perform Water/Energy audit in the house/college building/society/laboratory.
Learning outcomes:
• Student will learn the concept of Environmental management.
• Student will able to understand the concept of Environment Impact Assessment.
• Student will understand the concept of Environmental Economics and its audit.
• Student will learn the concept of Watershed Management and Waste Management.
• Students will be able to understand Energy Management.

<table>
<thead>
<tr>
<th>Unit/subunit</th>
<th>Curriculum</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>Unit-1 (A)</td>
<td>Introduction to Environmental management</td>
<td>5</td>
</tr>
<tr>
<td>1.1</td>
<td>Definition, goals, significance and scope of environmental management</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Development and Environmental linkages</td>
<td>1</td>
</tr>
<tr>
<td>1.3</td>
<td>Actions for Environmental protection- Indian initiatives</td>
<td>2</td>
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<tr>
<td>1.3.1</td>
<td>National committee on Environmental planning and co-ordination</td>
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<tr>
<td>1.3.2</td>
<td>Ministry of Environment, Forest and Climate change</td>
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<td>1.4</td>
<td>Environmental management practices</td>
<td>1</td>
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<tr>
<td>(B)</td>
<td>Applications of Environment Management System (EMS)</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>Definition of EMS, Environment Policy and components of EMS- Planning, Implementation, Checking, Review</td>
<td>2</td>
</tr>
<tr>
<td>1.6</td>
<td>Origin and management of Environment Impact Assessment (EIA)</td>
<td>1</td>
</tr>
<tr>
<td>1.6.1</td>
<td>Definition, Goal, Statement, Scope and Approach</td>
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<tr>
<td>1.7</td>
<td>International organization for standardization (ISO)</td>
<td>2</td>
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<tr>
<td>(C)</td>
<td>Environmental Awareness and public involvement</td>
<td>5</td>
</tr>
<tr>
<td>1.8</td>
<td>Life Cycle Assessment (LCA)</td>
<td>2</td>
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<tr>
<td>1.8</td>
<td>Preparation of LCA- Inventory</td>
<td>1</td>
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<tr>
<td>1.9</td>
<td>Applications of LCA in relations to sustainable development</td>
<td>2</td>
</tr>
<tr>
<td>Unit2</td>
<td>Environmental Audit and Economics</td>
<td>15</td>
</tr>
<tr>
<td>(A)</td>
<td>Environmental Audit</td>
<td>7</td>
</tr>
<tr>
<td>2.1</td>
<td>Basics of Environmental Audit and its need</td>
<td>1</td>
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<tr>
<td>2.2</td>
<td>Types of Environmental Audit</td>
<td>1</td>
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<tr>
<td>2.3</td>
<td>Environmental appraisal and Environmental Accounting</td>
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<tr>
<td>2.4</td>
<td>Environmental Audit Procedure</td>
<td>1</td>
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<tr>
<td>2.5</td>
<td>Case study</td>
<td>3</td>
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<tr>
<td>(B)</td>
<td>Environmental Economics</td>
<td>8</td>
</tr>
<tr>
<td>2.6</td>
<td>Valuation of environment-impacts:-</td>
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<td></td>
<td>Types of economic values</td>
<td>1</td>
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<td></td>
<td>Approach</td>
<td>1</td>
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<td>Valuation techniques</td>
<td>1</td>
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<td></td>
<td>Valuing Environmental Amenities</td>
<td>1</td>
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<tr>
<td>2.7</td>
<td>Environmental Costs and Benefit Analysis</td>
<td>2</td>
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<td>2.8</td>
<td>Cost benefit analysis of technology or process for pollution control</td>
<td>2</td>
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<tr>
<td>Unit-3</td>
<td>Restoration Ecology and Watershed Development</td>
<td>15</td>
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<tr>
<td>(A)</td>
<td>Restoration ecology and application of eco-restoration</td>
<td>5</td>
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<tr>
<td>3.1</td>
<td>Definition, principles, significancies, guidelines etc</td>
<td>5</td>
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<tr>
<td>(B)</td>
<td>Application of eco-system</td>
<td>3</td>
</tr>
<tr>
<td>3.2</td>
<td>Ponds, lakes, ground water resources</td>
<td>3</td>
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<tr>
<td>3.3</td>
<td>Sewage or waste water-recycling for supporting eco-systems</td>
<td>3</td>
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<tr>
<td>3.4</td>
<td>Restoration of solid waste dumping sites</td>
<td>3</td>
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<tr>
<td>(B)</td>
<td>Watershed Management</td>
<td>10</td>
</tr>
<tr>
<td>3.5</td>
<td>Concept of watershed management</td>
<td>2</td>
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<tr>
<td></td>
<td>Definition, principle, objectives, watershed morphology and characterization</td>
<td>2</td>
</tr>
<tr>
<td>3.6</td>
<td>Watershed functions and survey</td>
<td>2</td>
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<tr>
<td></td>
<td>Collection storage, dispersal, habitat, attenuation response, flushing etc.</td>
<td>2</td>
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<tr>
<td>3.7</td>
<td>Water balance studies and harvesting methods</td>
<td>3</td>
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<tr>
<td>3.8</td>
<td>Watershed management</td>
<td>3</td>
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<tr>
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<td>Factors, problems associated with watershed management, project-monitoring &amp; result indicators</td>
<td>3</td>
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<tr>
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<td>Water harvesting projects in India</td>
<td>3</td>
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<tr>
<td>Unit-4</td>
<td>Waste management and Energy management</td>
<td>15</td>
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<tr>
<td>(A)</td>
<td>Waste management</td>
<td>6</td>
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<tr>
<td>4.1</td>
<td>Introduction</td>
<td>2</td>
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<td></td>
<td>Definition, historical development, source and type based classification</td>
<td>2</td>
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<td>Environmental and health impacts due to solid waste and handling of it</td>
<td>2</td>
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<tr>
<td>4.2</td>
<td>Municipal solid waste management in India</td>
<td>2</td>
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<tr>
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<td>Generation, collection, segregation, transportation, processing and disposal, assessment of existing situations and possible areas for improvement</td>
<td>2</td>
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<tr>
<td>4.3</td>
<td>Treatment and disposal</td>
<td>2</td>
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<tr>
<td></td>
<td>Waste processing, composting, biogasification, hydrolysis, pyrolysis, gasification, sanitary landfills</td>
<td>2</td>
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<tr>
<td>(B)</td>
<td>Energy management</td>
<td>9</td>
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<tr>
<td>4.4</td>
<td>Energy and environment</td>
<td>3</td>
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<td>Human energy requirement</td>
<td>3</td>
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<td>Energy use pattern in different parts of the world and its impact on environment</td>
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<td>Sources of energy and their classification</td>
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<td>Energy forms and transformation</td>
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<td>Renewable energy integration and decentralized generation systems</td>
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<td>Energy modeling and project management</td>
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<tr>
<td>4.5</td>
<td>Bio-energy</td>
<td>3</td>
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<td>Biomass composition and types</td>
<td>3</td>
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<td>Conversion processes- liquification, energy plantation, biogas production and uses</td>
<td>3</td>
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<td>Environmental constraints</td>
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<td>Energy conservation and management</td>
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<td>4.6</td>
<td>Solar Energy</td>
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<td>Harnessing of solar energy</td>
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<td>Photovoltaics, solar collectors and concentrators</td>
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<tr>
<td></td>
<td>Solar thermal energy, Energy planning economic and fields visit.</td>
<td>3</td>
</tr>
</tbody>
</table>
References

3. nagement strategies (the 21st century perspective) Printice Hall PTR.
8. Watershed manual by B.K. Kakde (B1AF and LEAD India publication)
GUJARAT VIDYAPITH : AHMEDABAD
Faculty of Science and Applied Science, Sadra, Dist.: Gandhinagar
M.Sc. (Environmental Sciences and Technology) Semester-IV
EST-402 Environmental Management
(Syllabus of Practical portion) (In force from December, 2018)
(External Evaluation: 60% + Internal Evaluation: 40%)
(Total Teaching Hours=60, Credit=04)

Learning outcomes:
• Student will learn the concept of Environment Impact Assessment through case study.
• Student will able to understand the concept of ISO.
• Student will be able to perform Environmental auditing.
• Student will learn to design structures for water conservation and harvesting.
• Students will be able to learn various techniques used for Solid Waste Management.

1. Case study on EIA: Any one case study from the following- Mining/Hydel/ Irrigation/
   Thermal Power Plant/ any one industry.
2. Elements of ISO 14000 series standards.
3. Cost-Benefit analysis.
4. Environment auditing procedures and report writing.
5. Tracing of watershed and their morphological features from toposheets.
6. Designing structures for water conservation and harvesting based on field visit.
7. Solid waste management techniques.
GUJARAT VIDYAPITH: AHMEDABAD  
Department of Microbiology, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-IV  
EST-403: Research Part-III  
(Syllabus of practical portion) (In force from December, 2018)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=150, Credit=05)  

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Learning outcomes:

• Student will learn to present their research data in the form of Table and/ Figure.
• Student will able to discuss their research work under different headings like introduction, materials and methods, results, discussion etc.
• Student will learn to prepare slides for presentation.
• Student will learn to discuss their research work against faculty.

Student has to made power point presentation of his/her experimental results against faculty members of the Department (pre-thesis seminar). After approval of evaluation committee the student may submit his/her synopsis and dissertation. Dissertation will be evaluated through internal and external mode as per University norms.
GUJARAT VIDYAPITH : AHMEDABAD  
Department of Microbiology, Sadra, Dist.: Gandhinagar  
M.Sc. (Environmental Sciences and Technology) Semester-IV  
EC-401: Presentation of Research work in Seminar/Symposium/Conferences  
(Syllabus of practical portion) (In force from December, 2018)  
(External Evaluation: 60% + Internal Evaluation: 40%)  
(Total Teaching Hours=60, Credit=02)

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Learning outcomes:
• Student will learn to prepare slides for presentation.
• Student will able to discuss their research work.

Student has to present his/her experimental results with prior approval of Guide and Department, in at least one seminar/symposium/conference (Regional/ State/ National/ International level) conducted by any organization. Evaluation will be done by Departmental committee based on presentation status.