<table>
<thead>
<tr>
<th>Course type</th>
<th>Course code</th>
<th>Name of the course</th>
<th>T/P</th>
<th>Cr edit</th>
<th>Contact hrs per week</th>
<th>Exam duration in hrs</th>
<th>Component of Marks</th>
<th>Internal</th>
<th>External</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Env Science Core Course</td>
<td>US05CENV21</td>
<td>Environmental Biotechnology</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US05CENV22</td>
<td>Geological Science &amp; Oceanography</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US05CENV23</td>
<td>Environmental Pollution</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US05CENV24</td>
<td>Forensic science &amp; Remote Sensing</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US05CENV25</td>
<td>Practical</td>
<td>P</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>45</td>
<td>105</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Discipline specific elective (Any One)</td>
<td>US05DENV26</td>
<td>Env Health &amp; Stress Physiology</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td></td>
<td>-</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US05DENV27</td>
<td>Disaster Management</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td></td>
<td>-</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>
SARDAR PATEL UNIVERSITY
THIRD YEAR B.Sc. (FIFTH SEMESTER)
ENVIRONMENTAL SCIENCE
USO5CENV21(T) (Environmental Biotechnology)
(Four credit course, Four hours per week)
(Effective from June 2020)
(Total marks- 100, internal marks-30, external marks -70)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UNIT: 1 Fundamentals of Environmental Biotechnology: Introduction, Recombinant DNA technology and various steps involved, Enzymes Restriction Endonucleases, Vectors and their types, Applications of R DNA tech, Gene transfer in plants and animals with suitable examples, GMO and their risk assessment</td>
<td>25%</td>
</tr>
<tr>
<td>2</td>
<td>UNIT: 2 Tissue Culture Plant tissue Culture- Introduction, Totipotency of cell, General process, Tissue culture laboratory and Instruments, Nutrient media composition, Callus culture, Anther culture, Protoplast culture, Advantages and Limitations of plant Tissue culture Animal tissue Culture- Introduction, Types of Cuture- batch and continuous,Cell culture, Organ culture, Protoplast culture, Adherent vs Suspension culture, Primary culture, Techniques, Types of culture media, Applications, Cryopreservation</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>UNIT: 3 Bioremediation Introduction, Mechanism, Essential factors, Advantages/Disadvantages. Types of Bioremediation : In Situ-Intrinsic and accelerared, methods- Biostimulation, Bioaugmentation, Biosparging, Bioventing, Ex Situ- Composting, Landfarming, Biopiling,Bioreactor. Scope, Application, Bioremediation of - Contaminated soils, Aquifers, Marine Oil spill, Air pollutants,Xenobiotics</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>UNIT: 4 Phytoremediation Introduction, Mechanism, Types of Phytoremediation: Phytoextraction,Phytostimulation, Phytostabilization,Phytovolatilization,Phytotransformation, Rhizofiltration, Hyper accuulaters species, Types of Plants used for phytoremediation, Applications of Phytoremediation.</td>
<td>25%</td>
</tr>
</tbody>
</table>

Suggested Books for reference:

1) A textbook of Biotechnology – R.C. Dubey
2) Biotechnology- A textbook of Industrial Microbiology – Wulf Gueger and Anneliese Crueger
3) Biotechnology and Genomics – P.K. Gupta
4) Biotechnology- Expanding Horizons – B.D.Singh
5) A textbook of Biotechnology – H.K.Das
6) Textbook of Agriculture Biotechnology by Ahindra Nag
7) A Book of Tissue culture by Kalyan Kumar Dey
**SARDAR PATEL UNIVERSITY**  
**THIRD YEAR B.Sc. (FIFTH SEMESTER)**  
**ENVIRONMENTAL SCIENCE**  
**USO5CENV 22(T) (Geological Science & Oceanography)**  
*(Four credit course, Four hours per week)*  
*(Effective from June 2020)*  
*(Total marks- 100, internal marks-30, external marks -70)*

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DESCRIPTION IN DETAIL</th>
<th>WEIGHTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Geomorphology:</strong> Definition, Geomorphic processes: Gradation, degradation, weathering, erosion and aggradations, Diastrophism. River-its pattern; drainage system. Land form-characteristics. Mineral structure-introduction; composition; major and trace elements; mineral stability diagrams and control on the chemistry of natural waters; geochemical cycles.</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td><strong>Geological Hazards:</strong> Volcanism-Definition, Classification, characteristics and impacts. Earthquake-Definition, physical properties, earthquake severity, causes, prediction mitigation strategies. Definition, Physical characteristics, causes, prevention and control of Landslide, Flood, Tsunami, Drought, Cyclone.</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td><strong>Oceanography:</strong>-1: Introduction, Distribution of world ocean water bodies, Oceans nomenclature; shape, size and volume. Relief of the ocean floor-continental shelf, continental slope, mid ocean ridge, gyot, sea mount, Deep sea plain &amp; Trenches. Physical properties of seawater – temperature, dissolve oxygen, density, viscosity, surface tension and conductivity.</td>
<td>25</td>
</tr>
</tbody>
</table>

**Suggested Books for Reference :**

5) Environmental Geology : Donald R. Coates  
6) Oceanography – TOM Garrison  
# SARDAR PATEL UNIVERSITY
## THIRD YEAR B.Sc. (FIFTH SEMESTER)
### USO5CENV23 (Environnement Pollution)
*(Four credit course, Four hours per week) (Effective from June 2020)*
*(Total marks- 100, internal marks-30, external marks -70)*

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DESCRIPTION IN DETAIL</th>
<th>WEIGHTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Air pollution:</strong> Definition, Sources, Effects of air pollution on human health and materials, Effects of Indoor air pollutants, Air quality standards, Sampling of pollutant-particulate matter, gases, vapour. Measurement of pollutants-Dust particles, measurement of smoke density, Stack monitoring, bio monitoring, Prevention and Control of air pollution (Venturi scrubber, Wet scrubber, Electrostatic precipitator and Cyclone precipitator).</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td><strong>Soil Pollution:</strong> Sources of pollutant (pesticides, sewage, organic and inorganic contamination), Effects and control measures. <strong>Radiation Pollution:</strong> Basic Types of radiation, sources, effects of ionizing radiation, Control of Radioactive pollution, radiation protection, radioactive waste disposal methods.</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td><strong>Noise Pollution:</strong> Definition, Sources, measurement of sound, effect of noise on human health, noise pollution abatement and control. <strong>Thermal Pollution:</strong> Definition, Sources, effect on man and aquatic ecosystem and control methods.</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td><strong>Nuclear Pollution:</strong> Definition, Sources, effect on man and aquatic ecosystem and control methods. <strong>Vehicular Pollution:</strong> Introduction, Major pollutants of Automobile Emission, Impact of Automobile Pollutants. Indian scenario, Air quality with respect to SO2, SPM, NOX, Types of fuels used for vehicles, Automobile pollution abatement.</td>
<td>25</td>
</tr>
</tbody>
</table>

### Suggested Books for reference:

11. Air pollution (7 volume) A.C.Stern
SARDAR PATEL UNIVERSITY
THIRD YEAR B.Sc. (FIFTH SEMESTER)
ENVIRONMENTAL SCIENCE
USO5CENV24 (Forensic Science and Remote Sensing)
(Four credit course, Four hours per week)
(Effective from June 2020)
(Total marks- 100, internal marks-30, external marks -70)

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DESCRIPTION IN DETAIL</th>
<th>WEIGHTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forensic Science: Introduction, Scope and branches of forensic science. Basic principles of forensic science. Organizational setup of Forensic Science Laboratories – Central F.S.L. and State F.S.L. Crime scene characteristics, sketching, photography, location, collection and preservation of exhibits/evidences. Physical evidence; types, significance and analysis.</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Applications of Forensics: Cases of doubtful paternity – General principles, blood group systems used in problems of parentage; detectable blood group markers in blood stains, deterioration of blood stains. History and Development of Fingerprints, classification of fingerprints, Henry system and single digit classification. Applications of Forensics.</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Remote Sensing and GIS: Definition and Components, Development, Principles, Platforms and Types. Characteristics of sensors. High resolution sensors – IKONOS, Quickbird, CASI. Aerial Photography and Satellite Remote Sensing: Principles, Types. EMR Interaction with Atmosphere and Earth Surface; Satellites (Landsat and IRS) and Sensors. GIS Data Structures: Types (spatial and Non-spatial), Raster and Vector Data Structure. Image Processing (Digital and Manual) and Data Analysis: Pre-processing (Radiometric and Geometric Correction), Enhancement (Filtering); Geo-Referencing; Editing and Output; Overlays, Interpretation.</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Application of Remote Sensing and GIS: Land use/ Land Cover, Urban Sprawl Analysis; Forests Monitoring. Biodiversity management, weather monitoring, Atmospheric studies, Geospheric survey, Hydrospheric studies, wasteland management, natural disaster.</td>
<td>25</td>
</tr>
</tbody>
</table>

Reference Books:

1) Forensic science in criminal investigation and trial – 5th Edition by B R Sharma
2) Forensic science in India by B B Nanda
3) Forensic science- the basics 2nd Edition by Jay A Siegel & Kathy Mirakovits
4) Remote sensing and GIS by B Bhatta
5) Basics of Remote sensing and GIS by S Kumar
6) Remote Sensing Principles and applications by Dr B C Panda
SARDAR PATEL UNIVERSITY  
THIRD YEAR B.Sc. (FIFTH SEMESTER)  
ENVIRONMENTAL SCIENCE  
USO5CENV25(P) (Practicals based on theory)  
(Six credit course, Twelve hours per week)  
(Effective from June 2020)  
(Total marks- 150, internal marks-45, external marks -105)  
(Exam duration Six hours)  
PRACTICAL BASED ON ENVIRONMENTAL BIOTECHNOLOGY  
1. To study aseptic techniques of Tissue culture Laboratory  
2. Introduction to Lab instruments  
3. Coposting of solid waste-bioremediation  
4. Anther culture  
5. Callus culture  
6. Heavy metal removal using Eichhornea  
7. Study of Plants used for phytoremediation  
PRACTICAL BASED ON GEOLOGICAL SCIENCE & OCEANOGRAPHY  
1. Study of rocks (Igneous, Sedimentary and Metamorphic)  
2. Determination of Iron from given geographical area  
3. Analysis of soil profile of any specific area  
4. Determination of Aluminum from given geographical area  
5. Study of physical properties of minerals  
6. Estimation of Residual Chlorine and chloride demand  
7. Determination of density and salinity of seawater and its interrelationship  
8. Study of seismic profile of a specific area and its interpretation  
9. Estimation of River pattern and drainage system  
10. Study of major geomorphic features and their relationships with outcrops through physiographic models.  
PRACTICAL BASED ON ENVIRONMENTAL POLLUTION  
1. Determination of SO\textsubscript{x} From Ambient air  
2. Estimation of NO\textsubscript{x} From Ambient air  
3. Determination of Particulate Matter from Ambient air  
4. Estimation of Moisture content and pore space in the soil  
5. Assessment of Phosphorus from soil  
6. Determination of Sulfur from soil  
7. Determination of Copper from soil  
8. Noise pollution measurement using Sound Level Meter  
9. Introduction to Stack Monitoring Kit for Air Monitoring  
PRACTICAL BASED ON FORENSIC SCIENCE & REMOTE SENSING  
1. Remote sensing – map reading  
2. Preparation of wind rose from given data  
3. Cartography  
4. Topographic contours, topographic sheets of various scales on maps  
5. Introduction to crime detection devices  
6. Demonstration of crime scene and laboratory photography  
7. Fingerprint matching  
8. Hair and fibre analysis  
9. ABO and RH blood groups from whole blood  
N.B.: Submission of Academic visit/Study tours Reports to be given due weightage in Practical examination.
SARDAR PATEL UNIVERSITY  
THIRD YEAR B.Sc. (FIFTH SEMESTER)  
ENVIRONMENTAL SCIENCE  
USO5DENV26 (T)  
ENVIRONMENTAL HEALTH AND STRESS PHYSIOLOGY  
(Two credit course, Two hours per week)  
(Effective from June 2020)  
(Total marks- 50, External marks -50, Exam duration Two hours)

Unit I Environmental Health  
Concept of health and disease; Principles of epidemiology and epidemiological methods, aims of epidemiology

Unit II Diseases  
Concept on air, water, vector borne diseases; Some communicable diseases-- Viral hepatitis, dengue, Leishmaniasis; Non-communicable diseases - cardiovascular, diabetes; Immunology: elementary ideas about antigens and antibody, autoimmunity; Immunodeficiency diseases; Allergy – Antigen-mediated hypersensitivity, hypersensitivity pneumonitis, allergic rhinitis, ingestant allergy, dermatitis, drug sensitivity

Unit III Health Programs  
Health Programs in India; Demography and family planning; Nutrition and health; Health education; World health report; Health impact assessment

Unit IV Environmental Stress Physiology: Concept and fundamentals; Photoinhibition and photoacclimation; Stress-agents like temperature, oxygen, salinity on plant

Reference books:

1. Stress Physiology by D P Singh. New Age International Publisher


3. Environmental Health: From Global to local by Howard Frukin

4. A textbook of Env. Studies by Dr D K Asthana & Dr Meera Asthana
SARDAR PATEL UNIVERSITY  
THIRD YEAR B.Sc. (FIFTH SEMESTER)  
ENVIRONMENTAL SCIENCE  
USO5DENV27(T)  
DISASTER MANAGEMENT  
(Two credit course, Two hours per week)  
(Effective from June 2020)  
(Total marks- 50, External marks -50, Exam duration Two hours)

Unit I Understanding Disaster  
Concept and definitions of disaster; Hazard, vulnerability, risk, capacity: Types, trends, causes and consequences and control of various disasters, viz., Geological, Hydrometeorological, Biological and Technological disasters

Unit II Disaster Management  
Vulnerability of natural hazards in India; Disaster management cycle; Activities associated with various stages of cycles

Unit III Institutional Framework  
Constitutional frameworks in India – Role of Governments, Non Governments and State Government agencies

Unit IV Risk Assessment  
Concept and evaluation of risk; Hazard identification; Exposure assessment; Hazard assessment; Risk characterization; Man-made Environmental degradation; Problems related to toxic wastes and chemicals and radioactive substance disposal

Reference Books :

1. Disaster Management by Savindra Singh, Jeetendra Singh
2. Disaster Management and Preparedness by Nidhi Gupta, Dhawan and Ambrina Sardar Khan
3. Safety and Disaster Management by Dr S Arulsay and J Jeyadevi
4. Disaster Mitigation: Experiences & mitigations by Pradeep Sahni, Alka Dhameja, Uma Medury
5. Disaster Management at Health care settings by Shreen Gaber
## SARDAR PATEL UNIVERSITY
### B.Sc. Semester VI Environmental Science
Under Choice Based Credit System
Syllabus with effect from June 2020

<table>
<thead>
<tr>
<th>Course type</th>
<th>Course code</th>
<th>Name of the course</th>
<th>T/P</th>
<th>Credit</th>
<th>Contact hrs per week</th>
<th>Exam duration in hrs</th>
<th>Component of Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Env Science Core Course</td>
<td>US06CENV21</td>
<td>Environmental Microbiology</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30 Internal 70 External 100 Total</td>
</tr>
<tr>
<td></td>
<td>US06CENV22</td>
<td>Pesticide, Herbicide, Fungicide Toxicology</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30 Internal 70 External 100 Total</td>
</tr>
<tr>
<td></td>
<td>US06CENV23</td>
<td>Environmental Management &amp; Technology</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30 Internal 70 External 100 Total</td>
</tr>
<tr>
<td></td>
<td>US06CENV24</td>
<td>Environmental Legislation &amp; Biostatistics</td>
<td>T</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>30 Internal 70 External 100 Total</td>
</tr>
<tr>
<td></td>
<td>US06CENV25</td>
<td>Practical</td>
<td>P</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>45 Internal 105 External 150 Total</td>
</tr>
<tr>
<td>Discipline specific elective (Any One)</td>
<td>US06DENV26</td>
<td>Biofertilizers</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>- Internal 50 External 50 Total</td>
</tr>
<tr>
<td></td>
<td>US06DENV27</td>
<td>Green Technologies</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>- Internal 50 External 50 Total</td>
</tr>
</tbody>
</table>
**ENVIRONMENTAL SCIENCE**  
USO6CENV21(T) (Environmental Microbiology)  
(Four credit course, Four hours per week)  
(Effective from June 2020)  
(Total marks: 100, internal marks: 30, external marks: 70)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
<th>Weightage</th>
</tr>
</thead>
</table>
| I | UNIT: 1  
Role of micro-organisms in nutrient cycling  
Distribution and ecological importance of micro-organisms—Prototrophs, Chemolithotrophs, Organotrophs, Saprotrophs and Parasites and their environmental importance, Nitrogen, Phosphorus, Carbon, Sulphur and Iron Cycles with reference to the specific micro organisms involved.. | 25% |
| II | UNIT: 2  
Bio fertilizers  
Introduction, Isolation, starter culture, Mass cultivation, preparation of Carrier based inoculum and curing, Packaging and storage. Importance of Bacterial, Algal and fungal fertilizers (Ecto and Endo Mycorrhizae fungi), Phosphate solublizing Micro-organisms, Green manuring, Vermiculture, Bio pesticides, Biological control and integrated pest management | 25% |
| III | UNIT: 3  
Biomass energy and Bio fuels  
| IV | UNIT: 4  
Micro-organisms as food  
Single Cell protein, Advantages of SCP over plants and animal protein. Use of bacteria, algae and fungi for SCP production, Mushroom Cultivation, Types of Foods, Use of micro organisms in food preparation, Food Spoilage, Effect of temperature on food, Food Spoilage caused by various Micro-organisms, Botulism, Staphylococcal poisoning. | 25% |

Suggested Books for reference:
1) Introduction to Soil Microbiology _ Martin Alexander
2) Handbook of Biofertilizer and Vermiculture- Eiri Board
3) Biorefining of Biomass to Biofuels – Sachin Kumar, Rajesh Sani Springer Publication
4) Morden Food Microbiology – James M.J.
6) General Microbiology – Fifth – Roger Y. Stanier
7) Industrial Microbiology – A.H.Patel
8) A Textbook of Biotechnology – R.C.Dubey
9) Food Microbiology – William C Frazier, Dennis C Westhoff
10) Foods, facts and Principles- N Shakuntala Manay
SARDAR PATEL UNIVERSITY  
THIRD YEAR B.Sc. (SIXTH SEMESTER)  
ENVIRONMENTAL SCIENCE  
USO6CENV22(T) (Pesticide, Herbicide, Fungicide Toxicology )  
(Four credit course, Four hours per week)  
(Effective from June 2020)  
(Total marks- 100, internal marks-30, external marks -70)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
<th>Weightage</th>
</tr>
</thead>
</table>
| I    | **UNIT: 1**  
Introduction to Toxicology  
Definition, Biotransformation: Detoxification and Bio activation, Species differences and determining factors, Absorption, Distribution and Elimination of Xenobiotics, Dose Response relationship.  
Bioassay- Definition, Purpose of Bioassay, Selection of test organisms, Types of toxicology, Types of Bioassay, Pollutant Bioassay using Fish. | 25% |
| II   | **UNIT: 2**  
Pesticide Toxicology  
Classification, Toxicology and Impacts of pesticides , Mode of action and metabolism of Organochlorine insecticide, Dieldrin, Organophosphate insecticide- Parathon and Malathion, Carbamate insecticide- Carbraryl and Aldicrab. Case Study- DDT in Environment, Bio magnification, Pesticide resistance. | 25% |
| III  | **UNIT: 3**  
Herbicide Toxicology  
Classification, selectivity, uptake, chemistry, Mode of action of the following; Dichlorobenzyl, Dalapon, Aromatic Carbamates, Diuron and monouron, Triazines- Atrazine, Enothal, Paraguat, Phenoxy herbicide- 2,4-D and 2,4,5-T. | 25% |
| IV   | **UNIT: 4**  
Fungicide Toxicology  
Types, Selectivity, Mode of action. Chemistry of  
a) Copper and Mercury Derivatives  
b) Dithio Carbamates- Thiram, Ziram  
c) Captan  
d) Dichlone (Quinones), Benomyls  
e) Carboxiamides and Organophosphates | 25% |
Suggested Books for reference:

4) Toxic chemicals, Health & Environment – laine, L.B. Upton
5) Herbicides – Physiology, Biochemistry and ecology, Andus
6) Pesticides – Dhaliwal & balwinder Singh
7) Fungicides in plant Disease control – Neve
8) Biochemical effects of Environmental Pollutants – Lee
9) Pesticide pollution – Kudesia and Charaya
SARDAR PATEL UNIVERSITY  
THIRD YEAR B.Sc. (SIXTH SEMESTER)  
ENVIRONMENTAL SCIENCE  
USO6CENV23(T) (Environmental Management & Technology )  
(Four credit course, Four hours per week)  
(Effective from June 2020)  
(Total marks- 100, internal marks-30, external marks -70)

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DESCRIPTION IN DETAIL</th>
<th>WEIGHTAGE (%)</th>
</tr>
</thead>
</table>
| 1    | **Solid waste Management**  
Municipal Solid Waste- Definition, Sources, Classification, Properties of MSW, Factors affecting generation of waste and its Management- Onsite handling and processing, Collection of MSW types of collection system, Storage and transport, Waste Disposal, Recycling of waste | 25 % |
| 2    | **Hazardous waste**  
Definition, sources, properties, treatment system of hazardous waste; incineration, wet oxidation and fluidized bed combustion, risk involved in handling hazardous waste.  
**Bio-Medical Waste**  
Definition, Sources, Categories, Collection and handling in hospitals, Ministry classification and colour coding for Bio-medical waste. | 25 % |
| 3    | **Waste water treatment methods**  
| 4    | **Industrial waste water treatment:**  
Raw Material used, Manufacturing process, Sources of Wastes and alternate use of wastes and treatment of waste material in the following industries: Sugar Industry, Paper and pulp Industry, Pharmaceuticals, Tanning Industry, Textile Industry, Dairy Industry, Fertilizers, Petroleum refinery | 25 % |

**Suggested Books for Reference:**  
1. Waste water treatment for Pollution Control – soli J Arceivala  
2. Water and Waste water engineering – Treatment, disposal and reuse- Metcaff and Eddy Inc  
3. Handbook of Solid waste management – Frank Kreith, George Tchobanoglous  
4. Waste management and resource recovery – Charles R Rhyner  
5. River Pollution – L B Singh, P N Pandey, Bhola Mahto, R K Singh  
6. Hazardous waste management – Gaynor W Dawson, Basil W Mercer
## SARDAR PATEL UNIVERSITY
### THIRD YEAR B.Sc. (SIXTH SEMESTER)
#### ENVIRONMENTAL SCIENCE

USO6CENV24(T) (Environmental Legislations & Biostatistics)

(Four credit course, Four hours per week)

(Effective from June 2020)

(Total marks- 100, internal marks-30, external marks -70)

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DESCRIPTION IN DETAIL</th>
<th>WEIGHTAGE (%)</th>
</tr>
</thead>
</table>
| 1    | Environmental Impact Assessments (EIA) and ISO  
      Environmental Auditing: Concept, Typical Audit process, Benefits, Environmental Audit program in India. | 25% |
| 2    | Environmental Legislation:  
      a) The water (Prevention and Control of Pollution) Act, 1974  
      b) The Air (Prevention and Control of Pollution) Act, 1981  
      c) Environmental Protection Act, 1986  
      d) Hazardous Waste (Management and Handling) Rules, 1989 | 25% |
| 3    | Biostatistics: Introduction, need for sampling, Sampling Types, Sampling Methods, Sampling Design, Selection of samples, Data presentation. Hypothesis: Basic concepts, simple and composite hypothesis, significance level, size and power of the test, p-value and its interpretation. Neymann-Pearson Lemma and its application intesting of hypothesis. | 25% |
| 4    | Applications of Biostatistics: Measurement of Central tendency: Mean, Mode, Median, Standard Deviation, Variance, Standard Error, Probability: Introduction, Types, Distribution. Test of Significance: T-Test, Z-Test, Chi square Test, Correlation and Regression: Types, Degree, Methods. | 25% |

**Suggested Books for Reference:**

1. Environment and Pollution laws – S K Mohanty
2. Environmental Laws- Mishra and Agarwal
4. Environmental Impact Assessment Methodologies- Prof Y Anjeneyulu
5. Env Impact Assessment- Alan Gilpin
7. Methods in Biostatistics- B K Mahajan
SARDAR PATEL UNIVERSITY
THIRD YEAR B.Sc. (FIFTH SEMESTER)
ENVIRONMENTAL SCIENCE
USO6CENV 25(P) (Practicals based on theory)
(Six credit course, Twelve hours per week)
(Effective from June 2020)
(Total marks- 150, internal marks-45, external marks -105)
(Exam duration Six hours)

PRACTICALS BASED ON ENVIRONMENTAL MICROBIOLOGY

- Types and composition of Media
- Various streaking methods for N agar plate
- Serial Dilution technique
- To study gram staining
- Study of Cyanobacteria
- Techniques of Isolation, inoculation and subculturing of Algae/ Fungi/Bacteria
- Isolation of Nitrogen fixing bacteria
- Study of Algal and fungal biofertilizers
- Study of Vermiculture tech. (field visit)
- Bio gas / biodiesel production unit -visit
- Mushroom cultivation
- Preparation of Winogradsky column

PRACTICALS BASED ON PESTICIDE, HERBICIDE, FUNGICIDE TOXICOLOGY

1. To study the effect of Pesticide concentration on germinating seeds
2. To study the effect of Fungicide
3. Action of Herbicide on grasses
4. Academic Visit to Agriculture farm to study effect of pesticide, herbicide & insecticide

PRACTICAL BASED ON ENVIRONMENTAL MANAGEMENT AND TECHNOLOGY

1. Collection of MSW and identification and segregation of its components
2. Recycling of Organic waste of your institution
3. Visit to medical hospital to study biomedical waste, its segregation and disposal
4. Visit to Effluent Treatment Plant of any one industry

PRACTICAL BASED ON ENVIRONMENTAL LEGISLATIONS & BIOSTATISTICS

1) EIA case study
2) Central tendency sums
3) Computation of mean, mode, median and standard deviation
4) Probability calculations
5) Sums of significance using T test, z test, Chi square test, Co relation, Regression

Project work/ Dissertation and submission for 6th semester students

N.B.: Submission of Academic visit/ Study tours Reports and Project work thesis to be given due weightage in Practical examination.

SARDAR PATEL UNIVERSITY
THIRD YEAR B.Sc. (SIXTH SEMESTER)
ENVIRONMENTAL SCIENCE
USO6DENV26 (T)
BIOFERTILIZERS
(Two credit course, Two hours per week)
(Effective from June 2020)
(Total marks- 50, External marks -50, Exam duration Two hours)

Unit-I
**Microbes as biofertilizers** – Introduction of Biofertilizer, Types of Micro organisms used as biofertilizers ( Bacteria, Algae, Fungi, Aquatic fern)
Bacteria- Phosphate solubilizing bacteria, free living- Azotobacter, Klebsiella
Symbiotic Nitrogen fixers- Rhizobium, Azospirillum. Mass production of *Rhizobium*, *Azospirillum*, *Azotobacter*

Unit II
**Algae as Biofertilizer** - Benefits, Examples, Characteristics,
- Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, the role of blue green algae and *Azolla* in rice cultivation.

Unit-III
**Fungi as Biofertilizer** - Mycorrhizal association: Types of mycorrhizal association, occurrence and distribution, Vesicular Arbuscular Mycorrhiza (VAM) and its influence on growth and yield of crop plants. Aquatic Fern as Biofertilizer –*Azolla*

Unit IV
**Biofertilizers** – Types, Mass production, Career material, Application methods ( Seed treatment, Root dipping, Soil Application), Advantages and Disadvantages
Green manuring and organic fertilizers, Vermicomposting

**Suggested Readings :**
SARDAR PATEL UNIVERSITY
THIRD YEAR B.Sc. (SIXTH SEMESTER)
ENVIRONMENTAL SCIENCE
USO6DENV27 (T) GREEN TECHNOLOGIES
(Two credit course, Two hours per week)
(Effective from June 2020)
(Total marks- 50, External marks -50, Exam duration Two hours)

Unit – I
Green infrastructure, planning and economy
Green buildings; need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, its importance and implementation; Green planning: role of governmental bodies, concept of green cities

Unit – II
Applications of green technologies
Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats. Carbon capture and storage (CCS) technologies, promotion and/or subsidy of alternative forms of transportation for employees, (carpools, fuel-efficient vehicles)

Unit – III
Green chemistry
Introduction to green chemistry; principles and recognition of green criteria in chemistry; biodegradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives

Unit – IV
Green future
Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); role of advancement in science in developing environmental friendly technologies.

Suggested Readings