

**SARDAR PATEL UNIVERSITY**  
**B.Sc. Semester V Environmental Science**  
**Under Choice Based Credit System**  
**Syllabus with effect from June 2020**

Course type	Course code	Name of the course	T/P	Credit	Contact hrs per week	Exam duration in hrs	Component of Marks		
							Internal	External	Total
Env Science  Core Course	US05CENV21	Environmental Biotechnology	T	4	4	3	30	70	100
	US05CENV22	Geological Science & Oceanography	T	4	4	3	30	70	100
	US05CENV23	Environmental Pollution	T	4	4	3	30	70	100
	US05CENV24	Forensic science & Remote Sensing	T	4	4	3	30	70	100
	US05CENV25	Practical	P	6	12	6	45	105	150
Discipline specific elective (Any One)	US05DENV26	Env Health & Stress Physiology	T	2	2	2	-	50	50
	US05DENV27	Disaster Management	T	2	2	2	-	50	50

**SARDAR PATEL UNIVERSITY**  
**THIRD YEAR B.Sc. (FIFTH SEMESTER)**  
**ENVIRONMENTAL SCIENCE**  
**USO5CENV21(T) (Environnemental Biotechnology)**  
**(Four credit course, Four hours per week)**  
**(Effective from June 2020)**  
**(Total marks- 100, internal marks-30, external marks -70)**

Unit	Topics	Weightage
1	<b>UNIT: 1</b> <b>Fundamentals of Environmental Biotechnology:</b> 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	25%
2	<b>UNIT:2</b> <b>Tissue Culture</b> 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 Culture- batch and continuous, Cell culture, Organ culture, Protoplast culture, Adherent vs Suspension culture, Primary culture, Techniques, Types of culture media, , Applications, Cryopreservation	25 %
3	<b>UNIT: 3</b> <b>Bioremediation</b> Introduction, Mechanism, Essential factors, Advantages/Disadvantages. Types of Bioremediation : In Situ- Intrinsic and accelerated, methods- Biostimulation, Bioaugmentation, Biosparging, Bioventing. Ex Situ- Composting, Landfarming, Biopiling, Bioreactor. Scope, Application, Bioremediation of - Contaminated soils, Aquifers, Marine Oil spill, Air pollutants, Xenobiotics	25%
4	<b>UNIT: 4</b> <b>Phytoremediation</b> Introduction, Mechanism, Types of Phytoremediation: - Phytoextraction, Phytostimulation, Phytostabilization, Phytovolatilization, Phytotransformation, Rhizofiltration, Hyper accumulator species, Types of Plants used for phytoremediation, Applications of Phytoremediation.	25%

**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)**

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	<b>Geomorphology:</b> 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.	25
2	<b>Geological Hazards:</b> 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.	25
3	<b>Oceanography-1:</b> 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 & Trenches. Physical properties of seawater – temperature, dissolve oxygen, density, viscosity, surface tension and conductivity.	25
4	<b>Oceanography -2 :</b> Ocean Tides, Tidal waves, Estuarine environment; definition; types of estuaries; estuarine organisms; estuarine productivity; estuarine food webs. Coral Reefs, Marine Deposits and Ocean Resources. TS diagram -acoustical and optical characteristics of seawater. SOFAR channel. Insolation – long wave radiation. Effect of clouds. Sensible and latent heat transfer Bowen's ratio. Ocean heat transport – spatio temporal variability of heat budget terms and net heat balance.	25

**Suggested Books for Reference :**

- 1) Principle of Geomorphology – William D. Thornbury, New Age International Pub.
- 2) The Earth – Frank press and Raymond Siever- 3<sup>rd</sup> edition- W.H. Freeman and Company
- 3) Physical geography – Savindra Singh – Prayag pustak bhavan Pub.
- 4) Textbook of Geology : P.K.Mukherjee (2000) The world press Pvt.Ltd.
- 5) Environmental Geology : Donald R. Coates
- 6) Oceanography – TOM Garrison
- 7) Oceanography - Savindra Singh – Prayag pustak bhavan Pub.

**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)

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	<b>Air pollution:</b> 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).	25
2	<b>Soil Pollution:</b> Sources of pollutant (pesticides, sewage, organic and inorganic contamination), Effects and control measures. <b>Radiation Pollution:</b> Basic Types of radiation, sources, effects of ionizing radiation, Control of Radioactive pollution, radiation protection, radioactive waste disposal methods.	25
3	<b>Noise Pollution:</b> Definition, Sources, measurement of sound, effect of noise on human health, noise pollution abatement and control. <b>Thermal Pollution:</b> Definition, Sources, effect on man and aquatic ecosystem and control methods.	25
4	<b>Nuclear Pollution:</b> Definition, Sources, effect on man and aquatic ecosystem and control methods. <b>Vehicular Pollution:</b> Introduction, Major pollutants of Automobile Emission, Impact of Automobile Pollutants. Indian scenario, Air quality with respect to SO <sub>2</sub> , SPM, NO <sub>x</sub> , Types of fuels used for vehicles, Automobile pollution abatement.	25

**Suggested Books for reference :**

- 1) Environmental Engineering – Devis Cornwell 3<sup>rd</sup> edition (1998). Mc Graw Hill.
- 2) Environmental Engineering – Gerald Kiely (1998) Mc graw Hill
- 3) Environmental Engineering – A global Prospective (2000) edt by Gary Vanloon & Duffy. Oxford Pub.
- 4) Encyclopedia of Environmental pollution and Control – R.K.Trivedi
- 5) An Introduction to air Pollution – R.K.Trivedi and P.K.God (1998) Technology Pub.
- 6) Environmental Pollution control Engineering – C.S.Rao (1995) – Wiley Eastern ltd.
- 7) Nature and properties of Soil- N.C.Brady (1997) Mc. Millan pub.
- 8) Environmental Chemistry – A.K.De(1995), Widy Eastern.
- 9) Chemistry for Environmental Engineering- Sawyer, Mac Carty, Partein (1994) Mc. Graw Hill
- 10) Introduction to Environmental engineering and Sciences – Gilbert N. Masters (1998) Printice hall of India Pvt. Ltd New Delhi
- 11) Air pollution (7 volume) A.C.Stern
- 12) Air pollution Control Engineering – Noel De nevers – Second edition – Mc.Graw Hill international edition.
- 13) Environmental Pollution - Management and Control for sustainable Development – R.K.Khitoliya, S.Chand and company, New Delhi

**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)**

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	<b>Forensic Science:</b> Introduction, Scope and branches of forensic science. Basic principles of forensic science. Organizational set up 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.	25
2	<b>Applications of Forensics:</b> 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.	25
3	<b>Remote Sensing and GIS:</b> 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. <b>GIS Data Structures:</b> 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.	25
4	<b>Application of Remote Sensing and GIS:</b> Land use/ Land Cover, Urban Sprawl Analysis; Forests Monitoring. Biodiversity management, weather monitoring, Atmospheric studies, Geospheric survey, Hydrospheric studies, wasteland management, natural disaster.	25

Reference Books :

- 1) Forensic science in criminal investigation and trial – 5<sup>th</sup> Edition by B R Sharma
- 2) Forensic science in India by B B Nanda
- 3) Forensic science- the basics 2<sup>nd</sup> 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 chlorine 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<sub>x</sub> From Ambient air
2. Estimation of NO<sub>x</sub> 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 –Antibody-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
2. Handbook of Environmental Health & Safety, Principles & Practices, Vol.1 (3<sup>rd</sup> Edition) by Raquel Duarte- Davidson
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**

Course type	Course code	Name of the course	T/P	Credit	Contact hrs per week	Exam duration in hrs	Component of Marks		
							Internal	External	Total
Env Science  Core Course	US06CENV21	Environmental Microbiology	T	4	4	3	30	70	100
	US06CENV22	Pesticide, Herbicide, Fungicide Toxicology	T	4	4	3	30	70	100
	US06CENV23	Environmental Management & Technology	T	4	4	3	30	70	100
	US06CENV24	Environmental Legislation & Biostatistics	T	4	4	3	30	70	100
	US06CENV25	Practical	P	6	12	6	45	105	150
Discipline specific elective (Any One)	US06DENV26	Biofertilizers	T	2	2	2	-	50	50
	US06DENV27	Green Technologies	T	2	2	2	-	50	50

**SARDAR PATEL UNIVERSITY**  
**THIRD YEAR B.Sc. (SIXTH SEMESTER)**

**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)**

Unit	Topics	Weightage
I	<b>UNIT: 1</b> <b>Role of micro-organisms in nutrient cycling</b> 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	<b>UNIT: 2</b> <b>Bio fertilizers</b> 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	<b>UNIT: 3</b> <b>Biomass energy and Bio fuels</b> Biomass Resources for fuel generation, Biomass strategy, Biogas production. Bio fuels- Bio diesel, Bio diesel production from <i>Jatropha</i> , Bio ethanol as a fuel, Biological Hydrogen generation, Microbial fuel cell (MFC).	25%
IV	<b>UNIT: 4</b> <b>Micro-organisms as food</b> 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.
- 5) Basic and Practical Microbiology – R.M.Atlas (1986) Macmillan Pub.co.US.
- 6) General Microbiology – Fifth – Roger Y. Stanier
- 7) Industrial Microbiology – A.H.Patel
- 8) A Textbook of Biotechnology – R.C.Dubey
- 9) Food Microbiology – Willium 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)**

Unit	Topics	Weightage
I	<p><b>UNIT: 1</b>  <b>Introduction to Toxicology</b>            Definition, Biotransformation: Detoxification and Bio activation, Species differences and determining factors, Absorption, Distribution and Elimination of Xenobiotics, Dose Response relationship.  <b>Bioassay-</b> Definition, Purpose of Bioassay, Selection of test organisms, Types of toxicology, Types of Bioassay, Pollutant Bioassay using Fish.</p>	25%
II	<p><b>UNIT: 2</b>  <b>Pesticide Toxicology</b>            Classification, Toxicology and Impacts of pesticides , Mode of action and metabolism of Organochlorine insecticide, Dieldrin, Organophosphate insecticide- Parathion and Malathion, Carbamate insecticide- Carbraryl and Aldicrab.            Case Study- DDT in Environment, Bio magnification, Pesticide resistance.</p>	25%
III	<p><b>UNIT: 3</b>  <b>Herbicide Toxicology</b>            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.</p>	25%
IV	<p><b>UNIT: 4</b>  <b>Fungicide Toxicology</b>            Types, Selectivity, Mode of action. Chemistry of</p> <ol style="list-style-type: none"> <li>a) Copper and Mercury Derivatives</li> <li>b) Dithio Carbamates- Thiram, Ziram</li> <li>c) Captan</li> <li>d) Dichlone (Quinones), Benomyls</li> <li>e) Carboxiamides and Organophosphates</li> </ol>	25%

## **Suggested Books for reference :**

- 1) Wilson & Gisvold's – Textbook of Organic Medicinal & Pharmaceutical Chemistry, Edited by Jamie N. Delgado, William A. Remers(1998) – Lippincalt –Raven – Pub. Philadephia.
- 2) Principle of Medicinal Chemistry – William O. Foye, Thomas R. Remelee & David A. Williams (1995)- B.J. Heaverly Pvt. Ltd. New Delhi
- 3) Toxicology – principle and Applications – Raymond T.M. Niesink, Thon de vries, mannfred A. Hollinger (1996) – CRC press and open university of Netherland (1996)
- 4) Toxic chemicals, Health & Environment – lane, 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
- 10) Insecticide Biochemistry and Physiology – C.F.Wilkinson (1976), Plenium press New York
- 11) Environmental Chemistry – A.K.De (1995), Wiely Eastern.

**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)**

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	<p><b>Solid waste Management</b>  Types of Solid Waste- Municipal waste, Industrial Waste, Hazardous Waste, Bio-medical Waste, Typical generation rate of various waste.</p> <p>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</p>	25 %
2	<p><b>Hazardous waste</b>  Definition, sources, properties, treatment system of hazardous waste; incineration, wet oxidation and fluidized bed combustion, risk involved in handling hazardous waste.</p> <p><b>Bio-Medical Waste</b>  Definition, Sources, Categories, Collection and handling in hospitals, Ministry classification and colour coding for Bio-medical waste.</p>	25 %
3	<p><b>Waste water treatment methods</b>  Water pollution: Types, Sources, Causes and consequences, harmful effects. Water treatment processes: screening, aeration, chemical pre-treatment, Primary Treatment, Secondary treatment, Tertiary treatment. Flow rates and characteristics of wastewater, Wastewater treatment process- pre-treatment primary, secondary, and tertiary, Sewage irrigation, sewage farming</p>	25%
4	<p><b>Industrial waste water treatment:</b>  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</p>	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- Metcalf 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)**

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	<b>Environmental Impact Assessments (EIA) and ISO</b> <b>EIA:</b> Concept, Procedures, Scope, Review of EIS, Risk assessment. <b>ISO:</b> Introduction, Types, Structure of ISO 14000 Systems, Impact of ISO14000. <b>Environmental Auditing:</b> Concept, Typical Audit process, Benefits, Environmental Audit program in India.	25%
2	<b>Environmental Legislation:</b> 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	<b>Biostatistics:</b> Introduction, need for sampling, Sampling Types, Sampling Methods, Sampling Design, Selection of samples, Data presentation. <b>Hypothesis:</b> 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 in testing of hypothesis.	25%
4	<b>Applications of Biostatistics:</b> 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
3. A Handbook of Environmental Impact Assessment- V S Kulkarni, S N Kaul and R K Trivedi
4. Environmental Impact Assessment Methodologies- Prof Y Anjeneyulu
5. Env Impact Assessment- Alan Gilpin
6. Ecology and Environmental Science -4<sup>th</sup> Edition BY SVS Rana
7. Methods in Biostatistics- B K Mahajan
8. Fundamentals of Biostatistics – A M Goon, M K Gupta, B D Dasgupta

**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 6<sup>th</sup> semester students**

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



**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 :**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

**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**

1. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford University Press.
2. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications.
3. Baker, S. 2006. Sustainable Development. Routledge Press.
4. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. Green technologies for a more sustainable agriculture (No. 33721). United States Department of Agriculture, Economic Research Service.
5. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.
6. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press.