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	**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** Biomass Resources for fuel generation, Biomass strategy, Biogas production. Bio fuels- Bio diesel, Bio diesel production from *Jatropha*, Bio ethanol as a fuel, Biological Hydrogen generation, Microbial fuel cell (MFC).	25%
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.
5) Basic and Practical Microbiology – RM.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	**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- Parathion 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 :

1) Wilson & Gisvold's – Textbook of Organic Medicinal & Pharmaceutical Chemistry, Edited by Jamie N. Delagado, William A. Remers(1998) – Lippincalt –Raven – Pub. Philadephia.
2) Principle of Medicinal Chemistry – William O. Foye, Thomas R. Remelee & David A. Wlliams (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	**Solid waste Management** Types of Solid Waste- Municipal waste, Industrial Waste, Hazardous Waste, Bio-medical Waste, Typical generation rate of various waste. 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** 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	25%
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, TanningIndustry, Textile Industry, DairyIndustry, 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)

UNIT	DESCRIPTION IN DETAIL	WEIGHTAGE (%)
1	**Environmental Impact Assessments (EIA) and ISO** **EIA:** Concept, Procedures, Scope, Review of EIS, Risk assessment.**ISO:** Introduction, Types, Structure of ISO 14000 Systems, Impact of ISO14000. **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, Co-relation 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 -4th 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 horus)

PRACTICALS BASED ON ENVIRONMENTAL MICROBIOLOGY

Types and composition of Media
Various streaking methods for N agar plate
Serial Dilution techniqe
To study gram staining
Study of Cyanobacteria
\ Techniques of Isolation, Inoculation and subculturing of Algae/ Fungi/Bacteria
Iisolation 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 germiating 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 segrigationof 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 tendancy 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 horus)

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 Biofiertilizer - 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 horus)

Unit – I

Green infrastructure, planning and economy

Green buildings; need and relevance of green buildings over conventional buildings, construction ofgreen buildings; associated costs and benefits; outlined examples of green buildings; LEED certifiedbuilding; Eco-mark certification, its importance andimplementation; Green planning: role of governmental bodies, concept of greencities

Unit – II

Applications of green technologies

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermalmelting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detectionlighting, or programmable thermostats). Carbon captureand 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, reactionsand 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 asustainable future; major challenges and their resolution for implementation of green technologies;green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usageand 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.