

University of Mumbai



No. AAMS_UGS/ICC/2022-23/103

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments in Faculty of Science & Technology is invited to this office circular No. UG/143 of 2017 dated 31st July, 2017 relating to the revised syllabus M.Sc. (Life sciences) Specialization in Environmental Biotechnology (Sem.III & IV) (CBCS).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Life Science** at its meeting held on 31st May, 2022 and subsequently passed in the faculty and by the Board of Deans at its meeting held on 05th July, 2022 **vide** item No. 6.4 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.4 (R) and that in accordance therewith, the revised syllabus of M.Sc. (Life sciences) Specialization in Biotechnology (Sem.III & IV) (CBCS), has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032
11th October, 2022


(Dr. Shailendra Deolankar)
I/c. REGISTRAR

To

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments in Faculty of Science & Technology.

A.C/6.4(R)/11/07/2022

No. AAMS_UGS/ICC/2022-23/103

11th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies Life Science,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Life Science ,
- 6) The Co-ordinator, MKCL.


(Dr. Shailendra Deolankar)
I/c. REGISTRAR

py for information and necessary action :-

- 1. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 2. College Teachers Approval Unit (CTA),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
- 5. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 6. The Deputy Registrar, Executive Authorities Section (EA)**
He is requested to treat this as action taken report on the conce resolution adopted by the Academic Council referred to the a circular.
- 7. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 8. The Deputy Registrar, Special Cell,**
- 9. The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
- 10. The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

- 1. The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
He is requested to upload the Circular University Website
- 2. The Director of Department of Student Development (DSD),**
- 3. The Director, Institute of Distance and Open Learning (IDOL Administration Vidyanagari,**
- 4. All Deputy Registrar, Examination House,**
- 5. The Deputy Registrars, Finance & Accounts Section,**
- 6. The Assistant Registrar, Administrative sub-Campus Thane,**
- 7. The Assistant Registrar, School of Engg. & Applied Sciences, Kaly**
- 8. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 9. P.A to Hon'ble Vice-Chancellor,**
- 10. P.A to Pro-Vice-Chancellor,**
- 11. P.A to Registrar,**
- 12. P.A to All Deans of all Faculties,**
- 13. P.A to Finance & Account Officers, (F & A.O),**
- 14. P.A to Director, Board of Examinations and Evaluation,**
- 15. P.A to Director, Innovation, Incubation and Linkages,**
- 16. P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
- 17. The Receptionist,**
- 18. The Telephone Operator,**

Copy with compliments for information to :-

- 19. The Secretary, MUASA**
- 20. The Secretary, BUCTU.**

UNIVERSITY OF MUMBAI



**Revised Syllabus for
M.Sc.**

(LIFE SCIENCES)

**Specialization in Environmental
Biotechnology**

**Semester: III & IV
(CBCS)**

(With effect from the academic year 2022-23)

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc. (Life Sciences) Specialization in Environmental Biotechnology
2	Eligibility for Admission	M. Sc. Life Sciences Semester I and II, of University Department of Life Sciences, University of Mumbai.
3	Passing Marks	240/600 every semester.
4	Ordinances / Regulations (if any)	No. PG/ Univ./VCD/ ICC/ 201213/18.
5	No. of Years / Semesters	2 Semesters (Semester III & IV)
6	Level	Certificate/Diploma/UG/ PG
7	Pattern	Semester /Yearly
8	Status	Revised /New /
9	To be implemented from Academic Year	From Academic Year: 2022-2023

Date: 1st June 2022

Indu Anna George
6/6/2022

Signature:

Name: Dr. Indu Anna George

Chairman of BoS of Life Sciences

Signature:

Dr. Anuradha Majumdar

Dr. Anuradha Majumdar

Dean, Science and Technology

M. Sc. LIFE SCIENCES

SEMESTER III & IV

PREAMBLE:

The designers of the Master's Programme in Life Sciences are conscious of the fact that the learners who chose to pursue this programme in Life Sciences are from different disciplines and would need to be familiarized with the scope of Life Sciences. The courses in this programme are common to all learners in the first year (Semester I and II) and they are given a firm and comprehensive foundation in this multidisciplinary subject in this year.

The syllabus of the Semester III and IV of the Masters level in Life Sciences allows the learner to explore the different facets of Life Sciences. The learner has the option to select between the four specializations offered at the Second Year (Semester III and IV) of the programme namely: Biochemistry, Biotechnology, Environmental Biotechnology and Aquaculture Technology which would be awarded on the basis of seats available and merit.

The Semester III would allow the learner to appreciate the finer nuances of the specialization selected which would be detailed in each of the courses (4 theory and 4 practical) specific to that specialization.

The Semester IV gives the learner an opportunity for hands-on extension of the theory that was taught in the preceding semesters and design projects or develop methods that are scientifically relevant or mitigate a social challenge with the appropriate application of the tenets of this discipline through a comprehensive Literature Review (Course 403) and Project (Course 404). The learners would be encouraged to publish the results of their research or present them at relevant platforms such as seminars/ conferences etc.

The learner would earn 48 credits at the end of Semester III and IV (24 credits in each semester) that includes both theory and practical aspects as detailed below. In both semesters, the learner would be exposed to courses that impart core knowledge of the specialization and also expose the learner to skills relevant in that particular specialization. There are about 13 credits (denoted by an Asterix) devoted to this aspect of learning.

Value added courses would also be recommended to the learner as extra but pertinent reading.

The design of the M. Sc. Life Sciences – Specialization Environmental Biotechnology course for Semester III and IV have been outlined below:

Dr. Anuradha Majumdar (Dean, Science and Technology)

Prof. Shivram Garje (Associate Dean, Science)

Name of Chairperson (BoS): Dr. Indu Anna George.

Member (BoS): Dr. Nandita Mangalore

Member (BoS): Dr. Hemlata Ramchandran

Member (BoS): Dr. Tejashree Shanbhag

Member (BoS): Dr. Priya Sundarrajan.

Member (BoS): Dr. Nilima Gajbhiye

Syllabus framework and details as per University style and template

STRUCTURE FOR THE SEMESTER III AND SEMESTER IV

MASTER'S COURSE IN LIFE SCIENCES – SPECIALIZATION IN ENVIRONMENTAL BIOTECHNOLOGY.

SEMESTER III

PAPER	THEORY CREDITS 4				PRACTICAL CREDITS 2	
	1	1	1	1		
CODE	UT1	UT2	UT3	UT4	P1	P2
PSLSCEBT301	Core	Core	Core	Skill*	1.5	0.5
PSLSCEBT302	Core	Core	Core	Skill*	1.5	0.5
PSLSCEBT303	Core	Core	Core	Skill*	1.5	0.5
PSLSCEBT304	Core	Core	Skill*	Skill*	1.0	0.5 + 0.5

Total Credits: $4 \times 4 = 16$; $2 \times 4 = 8$; $16 + 8 = 24$.

EXAMINATION DETAILS:

Paper	PSLSCEBT301			PSLSCEBT302			PSLSCEBT303			PSLSCEBT304		
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practical		50	50		50	50		50	50		50	50
Total Marks			150			150			150			150

Grand Total: 600 marks.

SEMESTER IV

PAPER	THEORY CREDITS 4				PRACTICAL CREDITS 2	
	1	1	1	1		
CODE	UT1	UT2	UT3	UT4	P1	P2
PSLSCEBT401	Core	Core	Skill*	Skill*	1	0.5 + 0.5
PSLSCEBT402	Core	Core	Skill*	Skill*	1	0.5 + 0.5
PSLSCEBT403	Core	Literature Review			0.5	Writing a Research Paper (1.5)
PSLSCEBT404	Core	Internship/ Project			Internship/ Project (2.0)	

Total Credits: 4 x 4 = 16; 2 x 4 = 8; 16 + 8 = 24.

Examination Details:

Paper	PSLSCBT401			PSLSCBT402			PSLSCBT403**			PSLSCBT404***		
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practical		50	50		50	50		50	50		50	50
Total Marks			150			150			150			150

Grand total: 600 marks.

**** Assessment pattern for PSLSCEBTT403**

Internal: 10 marks for skill (test); 30 marks from Lit review Thesis submission = 40

External: 15 marks for skill (exam) and 45 marks of Lit review viva (exam) = 60

**** Assessment pattern for PSLSCEBTP403**

Practical: 25 marks skill (exam) and 25 marks draft paper (exam) = 50

***** Assessment pattern for PSLSCEBTT404**

Internal: 10 marks for skill (test); 30 marks internal assessment of project/ internship by guide = 40

External: 15 marks for skill (exam) and 45 marks for thesis submission = 60

***** Assessment pattern for PSLSCEBTP404**

Practical: 50 marks internship/ project viva by external (exam).

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part – II: Life Sciences – Specialization in Environmental Biotechnology

Semester III and IV

Choice Based Credit and Grading System

The academic year 2022 - 2023

UNIVERSITY OF MUMBAI, MUMBAI

MSc LIFE SCIENCES PROGRAMME (2-YEAR, FULL-TIME) SYLLABUS FOR SEMESTER III AND IV SPECIALISATION: ENVIRONMENTAL BIOTECHNOLOGY (ENBT)

1. PREAMBLE:

The Environmental Biotechnology Programme which is offered in the second year of the 2-year, full-time MSc Life Sciences Programme of University of Mumbai in Semesters III and IV, aims to introduce and elaborate the fundamental concepts and applications of biotechnology in all aspects of environment including its protection, restoration and sustainability. Considering the rising challenges of climate change, energy and environmental crisis, this course will emphasize upon the recent development of biotechnology for harnessing microbial potential in environmental applications. The course is structured to provide the students with fundamental concepts of environmental biotechnology, highlighting the importance of microbial ecology, their metabolism, methods for their characterization and scopes for implementation. Bioremediation and biodegradation principles, processes and applications will be discussed along with advanced applications in wastewater, oil recovery, bio-hydrometallurgy, bio-fuel, carbon storage and capture, etc. This course will offer the students a broad sense of understanding on how modern biotechnology is developed to achieve better environmental protection and sustainability through the use of microbes and microbial communities in pollution abatement to mitigation of climate change, bio-energy, bio-material to enzyme discovery.

There has been an inclusion of 'Hybrid mode' of teaching-learning (On-line & Off-line) component in the Syllabus, **coping with the changing trends and coming necessity for this mode of learning**. This component is kept facultative and freedom is given to the teaching faculties as well as the students to mutually decide the topics for on-line learning. The authorities will decide the final course of action for this novel concept. It would definitely be the future way of imparting education & knowledge to the students as it breaks the barriers of time, space & infrastructural needs.

2. PROGRAMME OBJECTIVES:

This Programme aims to introduce the students to various regional and global concerns regarding the environment, including the natural challenges, various types of environmental pollutants and their effects, the changing environment, and the developments of diverse technologies to detect, study and address these concerns. The subject aims to introduce specific examples and cases, and explain how chemical, biological and molecular sciences can be applied to identify and address issues of environmental concerns.

3. PROGRAMME OUTCOMES:

Environmental Biotechnology is an exciting, fast-growing interdisciplinary field with excellent career opportunities. Our Master's degree students in this field would acquire skills in diverse fields of expertise cutting across all the biological sciences subjects coupled with computing skills that are in demand in a wide range of industries and scientific fields.

4. STUDENTS' LEARNING OUTCOMES:

Students who successfully complete Environmental Biotechnology Specialisation of MSc Life Sciences (2-year, full-time) will be able to:

1. Recognise the various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity.
2. Investigate some examples of different types of environmental pollution and their impacts
3. Describe the applications of various fields including chemistry, biochemistry, molecular biology and/or microbiology, in understanding and addressing the above issues, as well as exploring environmental resources for new technologies.
4. Demonstrate an awareness of emerging concerns such as climate change, waste management or reductions in fossil fuels, and new technologies for addressing these.
5. Appreciate the scientific, ethical and/or social issues associated with certain applications of biotechnology for alleviating the environmental concerns.
6. Demonstrate advanced skills in performing literature searches in undertaking an in-depth case study of an environmental issue, and presenting a critical appraisal.

Our teachers have several years of experience in teaching multi-disciplinary subjects. They are actively involved in the field, with a variety of ongoing research programs and several international publications. We are committed to both practical and theoretical education; therefore, **our Master's students get an opportunity to work with us on our research projects in several industries/ scientific institutions and NGOs with whom we have been working closely.**

Graduates from our program will possess advanced knowledge of natural sciences. They have technical expertise in the field of biotechnology, including bio-energy technologies. They will be able to solve problems related to the use of the natural environment using various technologies, including remediation. They will be in their profession, able to use molecular techniques as a tool to draw conclusions about the state of the environment. When dealing with damage to the environment, they would identify the risks and take action to restore environmental balance. As the Master's programme gets to its concluding phase, our students would develop conviction to understand the desirability of continuing education, professional development and international cooperation, and will be well-prepared for doctoral studies if they choose this career path.

With this combination of skills and attitudes, we are confident that **our graduates are well prepared for a successful career in industry or academic institutions.**

5. PROGRAMME STRUCTURE & FRAMEWORK:

SEMESTER- III: THEORY COURSES

COURSE CODE/ TITLE	UNIT	UNIT TITLE	CREDITS	HOURS
THEORY COURSES				
PSLSCEBTT301 (Molecular Aspects of Environment)	I (C)	Epigenetics and Environment	4	15
	II (C)	Endocrine Systems and Environment (On-line & Off-line)		15
	III (C)	Hormone Action in Plants and Animals (On-line & Off-line)		15
	IV (S)	Mechanism of Signalling in Biome		15
PSLSCEBTT302 (Health Aspects of Environment)	I (C)	Natural Rhythms and their role in maintaining the Ecosystem	4	15
	II (C)	Health and Environment		15
	III (C)	Occupational Hazards (On-line & Off-line)		15
	IV (S)	Security and Safety measures (On-line & Off-line)		15
PSLSCEBTT303 (Environmental Technology Interventions)	I (C)	Bioinformatics (On-line & Off-line)	4	15
	II (C)	Remote Sensing (On-line & Off-line)		15
	III (C)	Databases in Environment Systems (On-line & Off-line)		15
	IV (S)	Geographical Information Systems		15
PSLSCEBTT304 (Methods and Applications in Environmental Research)	I (C)	Research Computing	4	15
	II (C)	Scientific Writing		15
	III (S)	ISO		15
	IV (S)	GMP / GLP		15

SEMESTER- III: PRACTICAL COURSES

Course Code	Course Title	Credits	No. of Hours
PSLSCEBTP301	Molecular Aspects of Environment	2	60
PSLSCEBTP302	Health Aspects of Environment	2	60
PSLSCEBTP303	Environmental Technology Interventions	2	60
PSLSCEBTP304	Methods and Applications in Environmental Research	2	60

SEMESTER IV: THEORY COURSES

COURSE CODE	UNIT	UNIT TITLE	CREDITS	HOURS
THEORY COURSES				
PSLSCEBTT401 (Applied Environmental Biotechnology- I)	I (C)	Environmental Toxicology (On-line & Off-line)	4	15
	II (C)	Analytical Techniques in Environmental Sciences		15
	III (S)	Biostatistics and Modelling- Practical approach		15
	IV (S)	IPR and Bio-safety		15
PSLSCEBTT402 (Environmental Management)	I (C)	Waste Management: Sources, Categories & Technologies (On-line & Off-line)	4	15
	II (C)	Environmental Legislation, ethics and policy		15
	III (S)	Bioremediation (case studies/ training in industrial plants)		15
	IV (S)	Genetic Engineering for Waste Management		15
PSLSCEBTT403 (Sustainability and Innovation & Literature Review)	I (C)	Environmental Sustainability and Innovation (On-line & Off-line)	4	15
	II (LR)	Literature Review		45
	III (LR)			
	IV (LR)			
PSLSCEBTT404 (Applied Environmental Biotechnology- II & Internship/ Project)	I (C)	Abatement technologies for detrimental effects of climate change	4	15
	II (I/P)	Internship/ Project		45
	III (I/P)			
	IV (I/P)			

SEMESTER- IV: PRACTICAL COURSES

Course Code	Course Title	Credits	No. of Hours
PSLSCEBTP401	Applied Environmental Biotechnology- I	2	60
PSLSCEBTP402	Environmental Management	2	60
PSLSCEBTP403	Environmental Sustainability and Innovation	2	60
PSLSCEBTP404	Internship/ Project	2	60

6. DETAILED SYLLABUS: SEMESTER III (ENVIRONMENTAL BIOTECHNOLOGY)

PAPER- PSLSCEBTT301: MOLECULAR ASPECTS OF ENVIRONMENT

Unit I: Epigenetics and Environment (15L)

Introduction to the topic; Environmental control of environment at the molecular level; Cell differentiation, stem cells and epigenetics; Developmental symbiosis; Survival mechanisms of embryonic defense; Environment and normal development; Teratogenesis and teratogens; Endocrine disruptors; Epigenetic origin of diseases and epigenetics and diseases; Disease intervention strategies targeting epigenetic changes; the Modern synthesis; Regulation through developmental regulatory genes; Evolution through developmental regulatory genes.

Unit II: Endocrine Systems and Environment [Hybrid mode- online & offline] (15L)

Exocrine and endocrine meanings; types of endocrine systems (glands); products of endocrine glands; role of endocrine systems in maintaining environment (internal & external); Endocrine systems in different animals; Interactions (positive & negative) among animals with endocrine glands; Role of endocrine glands with respect to ecological equilibrium; Performance of animals and phenotypic plasticity; Case studies of animals explaining role of endocrine systems affecting environmental structure (e.g., migration in fishes, aggression in canines, etc.).

Unit III: Hormone Action in Plants and Animals [Hybrid mode- online & offline] (15L)

Plant hormones- types, origin and functions (overview); Auxins; Gibberellins; Cytokinins; Abscissic Acid; Ethylene plant hormones; Brassinosteroides; Jasmonates; Salicylic Acid; Strigolactones; Other known hormones; Plant hormones or human usage; Animal hormones- types, origin and functions- overview and individual detailed study; Role of hormones in Environment- new, emerging field of research.

Unit IV: Mechanism of Signalling in Biome [Skill Enhancement] (15L)

Biochemical basis of signalling in living world; autocrine, paracrine, endocrine, exocrine and juxtacrine; receptors for signalling; Bio-mimicry; Applications of bio-mimicking for human usage - case studies; bio-signalling and its impact on Environmental well-being.

PRACTICALS:

PSLSCEBTP301: Molecular Aspects of Environment

1. Virtual demonstration of effect of natural teratogens like tobacco on avian foetus.
2. Carry out a case study of one human disorder having epigenetic origin.
3. Prepare a chart of different glands controlling signalling patterns in animals.
4. Make a comparative study of human endocrine glands.
5. Study the effect of various environmental factors (light, temperature, salinity) on the behaviour of local freshwater fish.
6. Make a list of different types of migrations in fishes and explain the same in view of respective endocrine systems effects.

7. Study various plant hormones for human usage and prepare one working model of any one of these.
8. List out all hormones found in vegetables of human consumption.
9. With an appropriate diagram, express the reprogramming of DNA methylation in zygote.
10. Prepare a model based on natural bio-mimicry for sustainable residential houses.
11. Observe the AVI of waggle dance of honeybees as a mean to bio-signalling.

REFERENCES:

1. Basic Genetics by D.L. Hartl. 1991. Jones & Bartlett Publications.
2. Microbial Genetics, Friefelder. 1987. Jones & Bartlett publications.
3. Molecular Biology of the gene 4th edition by Watson *et al*, The Benjamin / Cummings Co.
4. Molecular Cell Biology by Lodish. 1994. Baltimore Scientific American Brooks.

PAPER- PSLSCEBTT302: HEALTH ASPECTS OF ENVIRONMENT

Unit I: Natural Rhythms and their role in maintaining the ecosystem (15L)

Circadian rhythm, phase response curve; Circadian rhythms in plants, animals, microorganisms; biological clock in humans- anatomy and physiology; biological clocks in other animals- microorganisms to developed non-humans; molecular basis of circadian rhythm; Epigenetics and Chromatin Biology; Synchronization and masking; Zeitgebers- photic and non-photoc; Seasonal cycles in nature; role of natural cycles on environment.

Unit II: Health Aspects of Environment (15L)

Physical, Chemical, Biological agents in environment; Environmental Health Problems: Health problems related to the environmental degradation, vulnerable groups in society; Environmental factors that can potentially affect health; environment and health indicators; major environmental and health issues; Specific pollutants or issues; indoor and outdoor environment; Health problems; Human Bio monitoring; Environmental health and disease burden.

Unit III: Occupational Hazards [Hybrid mode- online & offline] (15L)

Occupational hazards- Physical, chemical, Biological; Occupational diseases- Pneumoconiosis, silicosis, Anthracosis, Byssinosis, Bagassosis, Astertosis, Farmers lung, Lead poisoning, Occupational cancer, Occupational Dermatitis, Radiation hazards; Occupational hazards of agricultural workers- somatic diseases, accidents, toxic hazards, physical hazards, respiratory diseases; accidents in industry, sickness absenteeism, health issues due to industrialization; Airborne allergens, seasonal changes, mode of dispersal, disease intensity and control.

Unit IV: Security and safety measures [Skill Enhancement] [Hybrid mode- online & offline] (15L)

Measures for securing safety and health of workers; preservation of occupational diseases- medical measures, engineering measures; Legislation - The Factories Act, 1948; Human health problems due to pollution; public health programs; Food borne diseases: Types, symptoms and prevention; Food poisoning - types of food poisoning, prevention and control, indicators of health, food safety.

PRACTICALS: PSLSCEBTP302: Health Aspects of Environment

1. Study of zeitgebers in two each of invertebrates & vertebrates
2. Types of biological rhythms in plants and animals
3. Structure of supra-schismatic nuclei and their role.
4. To study the effect of environmental factors viz., light, temperature and water currents in aquatic & terrestrial ecosystems.
5. Study of byssinosis.
6. Study of pneumoconiosis.
7. Documentation of allergic diseases and causes.
8. Safety devices in industries, including personal protective equipment.
9. Survey and documentation of occupational diseases and causes in given areas.
10. Respiration disorder in industrial workers.
11. Occupational health hazards in agricultural workers

REFERENCES:

1. Beaglehole, R., Bonita, R. and Kjellstrom, T. 2006. Basic epidemiology. 2nd Ed. WHO.

2. Benjamin O. Ali. 2008. Fundamental principles of occupational health and safety, Handbook of Occupational Safety and Health. 2Ed. Geneva : International Labour Office, 2008.
3. David N. Petley. 2009. Environmental Hazards: Assessing Risk and Reducing. 5th Ed.
4. Gloria J. Hathaway, Nick H. Proctor, James P. Hughes. 2014. Chemical Hazards of the Workplace. 5th Ed.
5. Jagbir Sing. 2007. Disaster Management: Future challenges and Opportunities, I.K. International.
6. Kulkarni, G. K. 2008. Implementation of occupational health legislation at work place- Issues and Concerns.
7. Paul R. Hunter. 1997. Waterborne disease: Epidemiology and Ecology, John Wiley and Sons Ltd., Chichester.
8. Peter H. Wald, and Gregg M. (Ed). 2016. Stave Proctor and Hughes. Physical and Biological Hazards of the work place. 3rd Ed.
9. Wisner, B. and Adams, J. 2002. Environmental Health in emergencies and disasters- A Practical Guide, World Health Organization.

PAPER- PSLSCEBTT303: ENVIRONMENTAL TECHNOLOGY INTERVENTIONS

Unit I: Bioinformatics [Hybrid mode- online & offline] (15L)

What is Bioinformatics and its relation with molecular biology, Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer), Data generation; Generation of large-scale molecular biology data (through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.

General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum).

Sequence Alignments and Visualization, Introduction to Sequences, alignments and Dynamic Programming, Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.

Unit II: Remote Sensing [Hybrid mode- online & offline] (15L)

Remote sensing: History and development, definition, concept and principles, Energy resources, radiation principles, EM Radiation and EM Spectrum, Interaction of EMR with atmosphere and earth's surface Unit;

Platforms: Types and their characteristics, Satellites: characteristics (geo-stationary and sun-synchronous), Earth Resources Satellites (LANDSAT, SPOT, IRS, IKONOS satellite series) and Meteorological satellites INSAT, NOAA, GOES);

Sensors: Types and their characteristics, across track (whiskbroom) and along track (pushbroom) scanning, Optical mechanical scanners (MSS, TM, LISS, WiFS, PAN), Concept of resolution (spatial, spectral, temporal, radiometric) as well as basic concept and principles of thermal, microwave and hyperspectral sensing;

Image interpretation: Basic principles, types, steps and elements, Techniques of and instruments for visual interpretation and interpretation keys; Multidate, multispectral and multidisciplinary concepts; Remote sensing data products and their procurement: Ground truth collection (spectral signatures), commonly used ground truth equipment (use of radiometers), Display forms (computer printouts, thematic maps, dot density maps).

[Theory lectures will be supplemented with field level demonstration of application of RS in various fields such as urban planning, biodiversity mapping, etc.]

Unit III: Databases in Environment Systems (15L) [Hybrid mode- online & offline]

Databases: Definition (Environmental Index), importance, purpose, contents, resources; Types of Databases relating to Environment Systems: Agricultural & Environmental Science Database, Web of Science, Ecology Abstracts, GreenFILE, CQ Researcher, CAB Direct, BIOSIS Citation Index, Water Resources Abstracts, TOXLINE, SciFinder-n, PAIS International

Unit IV: Geographical Information Systems

(With Hands-on training in field) [Skill Enhancement] (15L)

GIS: Fundamentals of GIS, vector, raster and attribute data, models, vector and raster data structure, Spatial data input and editing, Visualization and query of Spatial data, Spatial data transformations, Spatial analysis;

Multi-image manipulations: Spectral rationing, Vegetation indices, Principal components analysis; Multi and Hyper-spectral image classification, Supervised and un-supervised algorithms; Object based classification;

Global navigational satellite system: Basics of GNSS, Concept of Global Positioning System (GPS), working of GPS, types of GPS, Differential GPS, future of GPS and applications of GPS.

[Theory lectures will be supplemented with field level demonstration of application of GIS]

PRACTICAL:

PSLSCEBTP303: Environmental Technology Interventions

1. Training for use of NCBI and Uniport resources
2. Use of various Genome Data bases
3. Preparation of databanks of proteins, nucleotide sequence and molecular modelling.
4. Similarity searches using tools like BLAST, and interpretation of results
5. Multiple sequence alignment using ClustalW
6. Applications of Databases of Environmental Systems with real-life case studies.
7. Report on Operational introduction to Remote Sensing and GIS Data and useful Software functions
8. Integrate various Remote Sensing Data for GIS based Suitability Analysis
9. Hands-on Training on GPS Survey and Plotting
10. Image interpretation of land use/water, vegetation and lithology.
11. Study of geological/ contour/ drainage pattern maps.

REFERENCES:

1. Jain, H.C. 2015. Radiation and Man, National Book Trust, New Delhi.
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3. Murlikrishna, I.V. 1995. Remote Sensing and GIS for Environmental Planning.
4. Srikantaswamy, S. 2008. Essential of Remote Sensing.
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6. Joseph, G. 2009. Fundamentals of Remote Sensing. University Press.
7. Huisman, O., de RA (Ed.). Principles of Geographic Information Systems, Fourth Edition. ITC Educational Textbook Series, ITC. Enschede, The Netherlands.
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11. Proteomics- Pennigton & Dunn (2002). Viva books publishers, New Delhi
12. Bioinformatics- A practical guide to the analysis of Genes & Protein 2nd ED Andreas, Baxevanis and Francis Ouellette 2001. John Wiley & Sons.

PAPER- PSLSCEBTT304: METHODS AND APPLICATIONS IN ENVIRONMENTAL RESEARCH

Unit I: Research Computing (15L)

Scientific Research: Definition, Characteristics, types, need of research, Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), actual investigation.

Research Computing: Introduction, purpose and products of research, overview of research process, internet research, participants and research ethics, reviewing literature, design and creation, experiments, quantitative data analysis, presentation of research.

Use of word processing, spread-sheet and Database software, plotting of graphs, drawing inferences from data.

Unit II: Scientific Writing (15L)

An Insight into Research: Definition and basic concepts, objectives, significance and techniques of research, finding research materials- literature survey, compiling records, Definition and kinds of scientific documents: Research paper, Review paper, Book Reviews, Theses, conference and project reports (for the scientific community and for funding agencies), Components of a research paper: The IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations, Dealing with publishers: Submission of manuscript, ordering reprints. d) Oral and poster presentation of research papers in conferences/symposia, Preparation and submission of research project proposals to funding agencies.

Unit III: ISO [Skill enhancement] (15L)

International Organization for Standardization (ISO): ISO history, mission and structure; Development of Standards; Key quality concepts of continuous improvement and effectiveness that are fundamental to ISO Standards; Types of ISO Certification: Quality Management (ISO 9000 family); Environmental Management (ISO 14000 family); Information Security Management (ISO/IEC 27000 family), Occupational Health and Safety Management (ISO 45000 family).

Unit IV: Good Manufacturing Practices & Good Laboratory Practices (GMP/ GLP) [Skill Enhancement] (15L)

GMP and GLP: Definition, understanding the regulations, Awareness, Documentation requirements and Data Analysis;

Immunodiagnosics, drug delivery, GLP and GMP Immunodiagnosics: Introduction, antigen-antibody binding interactions and assays;

Immunoassays- types [RIA, ELISA] and specific applications; Immuno-histochemistry- principle and techniques;

Drug delivery: Various drug delivery systems, targeting potentials; systems used for delivery of biotechnological products (Liposomes, microspheres, nano-particles, immobilization techniques, etc.)

PRACTICAL:

PSLSCEBTP304: Methods and Applications in Environmental Research

1. Formulate a research problem and devise a proper solution to solve the same. Write down the steps/ flowchart/ algorithm.
2. Prepare the skeleton of a research paper based on the problem identified/ taken in Practical #1.
3. Write down the components of a research paper and explain significance of each component. Add a note on relevance of each one.

4. Topical problem solving: A company wants to get accreditation with certain ISO standardisation. You are the consultant. Convince the client about non-feasibility of that standard and suggest the appropriate one. Make a case study of the same.
5. Track down a particular drug in a human body. Study the regular drug delivery system & passage and suggest a better & more effective one. Make a case study of the same.

REFERENCES:

1. Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006)
2. Research Methodology: Methods and Techniques (Paperback) by C.R. Kothari. 2019. New Age Publishers.
3. Basic of Qualitative Research (3rd Edition), Juliet Corbin• & Anselm Strauss:, Sage Publications (2008).
4. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams. 2016.
5. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (Paperback) by John W. Creswell. 2018.
6. Research Methodology (Kindle Edition) by R. Panneerselvam. 2014. PHI Learning.
7. ISO Certification.[Link: https://irqs.co.in/iso/certification/iso-9001-certification/?utm_term=iso%20qms%20certification&utm_campaign=ISO+9001+Certification+2021&utm_source=adwords&utm_medium=ppc&hsa_acc=4061859907&hsa_cam=15365497124&hsa_grp=130237578916&hsa_ad=564185495690&hsa_src=g&hsa_tgt=kwd-43648922285&hsa_kw=iso%20qms%20certification&hsa_mt=b&hsa_net=adwords&hsa_ver=3&gclid=EAIaIQobChMIwKLv5Zec-AIVCx4rCh2FNQVAEAMYASAAEgJ1_D_BwE]
8. 10 Good Things about SMEs.
[Link: <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100283.pdf>]
9. Doing Your Research Project: A Guide for First-Time Researchers in Education, Health and Social Science (Paperback) by Judith Bell. 2005. Open University Press.
10. Research Methodology: A Step-By-Step Guide for Beginners (Paperback) by Ranjit Kumar. 2019 5th Edition.

SYLLABUS: SEMESTER IV (ENVIRONMENTAL BIOTECHNOLOGY)

PAPER PSLSCEBTT401: APPLIED ENVIRONMENTAL BIOTECHNOLOGY- I

Unit I: Environmental Toxicology [Hybrid mode- online & offline] (15 L)

Introduction to toxicology, scope of environmental toxicology, subspecialties of toxicology, description and terminology of toxic effects, factors influencing toxicity, drug toxicity, biochemical basis of toxicity- mechanism of toxicity and receptor mediated events, acute and chronic toxicity. Selective toxicity; Bioaccumulation and Biomagnifications of toxic materials in food chain; Basic concepts of Environmental forensics; Concepts of Bioassay- types, characteristics. Importance and significance of bioassay, field based microbial bioassay for toxicity testing, particulate matter sources, bioassay for residue analysis.

Unit II: Analytical Techniques in Environmental Sciences (15L)

Advances in various analytical techniques used in environmental biotechnology; Gene Transfer Techniques: Physical- Biolistic Method, Chemical- Calcium chloride and DEAE Methods, Biological *in vitro* package method- Screening and Selection of recombinants- Direct Methods- Selection by Complementation, Marker inactivation Methods, Indirect Methods- Immunological and Genetic Methods; PCR, Blotting (Southern, Western, Northern) Techniques, RFLP and Application, RAPD and Application, Microarray.

Unit III: Biostatistics and Modelling- [Skill Enhancement] (15L)

Role of modelling in environmental sciences, Model classification deterministic models, stochastic models, steady state models, dynamic models, different stages involved in model building. Simple microbial growth kinetics Monod equation, methods for formulation of dynamic balance equations mass balance procedures; Models of population growth and interactions Lotka Volterra model, Leslie matrix model, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models, validation and forecasting.

Unit IV: IPR and Bio-safety [Skill Enhancement] (15L)

IPR: Introduction to IPR, Types of IP (Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications), Protection of GMOs, IP as a factor in R&D; IPs of relevance to Biotechnology); Indian Patent Act 1970 & recent amendments; Concept of Prior Art and Patent filing Procedures: National & PCT filing procedures. Patent Databases: Searching International Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), PATENTScope (WIPO), IPO, etc.)

Bio-safety: Introduction (Historical Background), Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines- Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee for GMO applications in food and agriculture; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Besides, Individual/ Group project/s will be assigned by the respective faculty.

PRACTICAL:

PSLSCEBTP401: Applied Environmental Biotechnology- I

1. Determination of solid food adulteration.
2. Methods of prevention of food poisoning.
3. Determination of liquid food adulteration.
4. Estimation of LC50 value in mosquito larvae.
5. Determine the histotoxicity/ histopathology of a given sample.
6. Spot test for the detection of nitrate/ nitrite poisoning.
7. Histological processing of organs for toxicological tests
8. Determination of fluoride content in a given sample.
9. Determination of differential leukocyte count of the pesticide treated blood smear.
10. Paraffin sectioning and staining techniques
11. Determination of toxic chemicals in different samples.

REFERENCES:

1. Meera Asthana and Astana, D.K. 1990. Environmental pollution and Toxicology, Alka Printers.
2. Sharma, P.D. 1994. Environmental biology and Toxicology, Rastogi and Lamporary.
3. Sood, A., Sarup and Sons, 1999. Toxicology, New Delhi.
4. Park, J.E. and Park, K. 1985. Text book of Preventive and Social Medicine, Banosidas Bharat Publishers, Jabalpur.
5. Anisa Basheer. 1995. Environmental Epidemiology, Rawat Publication, Jaipur, New Delhi.
6. Bour, E.J. 1982. Introduction to Chemical Instrumentation, 4th Ed., Wiley & Sons.
7. Christian, G.D. 2001. Analytical Chemistry, 5th Ed., John Wiley and Sons Inc., India.
8. Khopkar, S.M. 1998. Basic concepts of Analytical Chemistry, 2nd Edition, New Age International Publ.
9. Khopkar, S.M. 1993. Environmental Pollution analysis, Wiley Eastern Ltd.
10. Ranade, Rashmi and Sanjay Deshmukh. 2013. Handbook of techniques in Biotechnology. Stadium Press India Pvt. Ltd., New Delhi, India. ISBN: 9978-93-80012-55-1. 379p.
11. Skoog, D.A., Holler, F.J. and Nieman, T.A. 1980. Principles of Instrumental analysis, 5th Ed. Thomson Asia Pvt. Ltd., Singapore.
12. Vogel, A.I. 1998. Quantitative analysis, 6th Edition, Prentice Hall Inc.
13. P. Narayanan, Intellectual Property Laws, Eastern Law House.
14. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.
15. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

PAPER PSLSCEBTT402: ENVIRONMENTAL MANAGEMENT

Unit I: Waste Management: Sources, Categories & Technologies (15L) [Hybrid mode- online & offline]

Sources, generation, classification & composition of solid wastes. Solid waste management methods- Sanitary land filling, Recycling, Composting, Vermicomposting, Incineration, energy recovery from organic waste;

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment; Hospital Waste Management, Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments);

Disaster Management, Fly ash generation & utilization, Primary, secondary & tertiary & advance treatment of various effluents.

Unit II: Environmental Legislation, Ethics and Policy (15L)

Introduction to Law and Policy: Basic concept of Law and Policy (Importance & difference; International Conferences impacting Indian legal system such as Stockholm 8 conference, Rio conference, Rio+5, Rio+10 Rio+20;

Environmental Policies in the Indian Constitution - Role of constitution in environment protection, Fundamental rights and duties, Article 48A, 51A (g), 58A, etc.;

Environmental Laws in India: Water Act, 1974, Air Act, 1981, Indian Forest Act, 1927/1982, EPA, 1986, The Wildlife Act, 1972, The Biological Diversity Act, 2002, Others;

Rules and Regulations (as amended): Hazardous Waste Rules, Solid Waste Management Rule, Biomedical Waste Rules, Batteries Rules, E-waste rules, Construction and Demolition waste Rules, Concept of Eco sensitive zones, Coastal Regulation Zone, Others;

National Environmental Policy, Ethical dilemma, Issues of Sustainable Development;

Unit III: Bioremediation (case study/ training in industrial plants) [Skill Enhancement] (15L)

Introduction, constraints and priorities of Bioremediation, Bio-stimulation of naturally occurring microbial activities, Bio-augmentation, in situ, ex situ, intrinsic & engineered bioremediation;

Solid phase bioremediation - land farming, prepared beds, soil piles, Phyto-remediation. Composting, Bio-venting & Bio-sparging; Liquid phase bioremediation- suspended bioreactors, fixed bio-film reactors;

Concept of bioremediation (in situ & ex situ), Bioremediation of toxic metal ions bio-sorption and bioaccumulation principles. Concepts of phyto-remediation. Microbial leaching of ore- direct and indirect mechanisms. Mining and metal. Use of microorganisms in augmentation of petroleum recovery. Biotechnology with special reference to Copper and Iron.

[Skill- based training at plant site (training to be conducted at Project sites of NEERI Mumbai, and/ or at Project 'Nisargayan' of Enviro-vigil at Kalyan)].

Unit IV: Genetic Engineering for Waste Management [Skill Enhancement] (15L)

Genetically Modified Organisms (animals and plants) and their potential/ and application in environment management;

Technologies for converting Organic Waste in to Compost to support rural and semi-urban farming;

Application of Integrated Bio-systems (integration of bioprocesses) for the conversion of biodegradable materials and wastes into products

[Tutorial-cum-Skill-based training will be conducted at 'Plant site/s' of Corporate organisations such as Excel Industries, Goregaon, Mumbai].

PRACTICAL:

PSLSCEBTP402: Environmental Management

1. Field Visits to Municipal & Private Waste Management Centres will be arranged. A report based on the field visits highlighting learning outcomes would be prepared individually by students, for submission.
2. Preparation of a critical evaluation report on International Environmental Laws and Policies: UNFCCC, Paris climate accord or Paris climate agreement 2015, Kyoto Protocol, Convention on Biodiversity, International Solar Alliance, CITES, Ramsar Convention, Basel Convention, MARPOL, Cartagena Protocol on Bio-safety, AGENDA 21, Others.
3. Tutorials-cum-Skill-based training to be conducted at 'Plant site/s' of Corporate organisations such as Excel Industries, Goregaon, Mumbai; and other relevant Organisations.

REFERENCES:

1. Solid Waste Management. Central Pollution Control Board (CPCB), New Delhi.
2. John Arundel 1995. Sewage and Industrial Effluent Treatment. Blackwell Science Publishers.
3. Metcalf and Eddy. 2017. Waste Water Engineering, McGraw-Hill International.
4. Schmitz, R.J. 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
5. Doabia, T.S. 2017. Environmental and Pollution Laws in India. 3rd Edition. Publisher: Lexis Nexis.
6. Ecotechnology for pollution control & environmental management - By R.K.Trivedi & Arvind Kumar.
7. Agrawal, K.C. 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
8. Diwakar Rao, P.L. 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad, India.
9. Hosetti, B.B. and Arvind Kumar. 1998. Environmental Impact Assessment and Management, Daya Publishing House, Delhi.
10. Leelakrishnan, P. 2016. Environmental Law in India. 4th Edition. Publisher: Lexis Nexis.
11. Mohanty, S.K. 2009. Environment and Pollution Laws. Publisher: Universal.
12. Leelakrishnan, P. 2006. Environmental Law Case Book. 2nd Edition.
13. Divan Shyam and Rosecranz, Armin. 2002. Environmental Law and Policy in India: Cases, Material and Statutes. Publisher: Oxford.

PAPER PSLSCEBTT403: ENVIRONMENTAL SUSTAINABILITY AND INNOVATION & LITERATURE REVIEW

Unit I: Environmental Sustainability (15L) [Hybrid mode- online & offline]

Sustainability: concept, political and technical dimensions; Globalisation, civil society and governance: The challenges for the 21st Century; Current state of India's environment and the policy changes; Environment, poverty and sustainable livelihoods; Governance for sustainable development; Protection of traditional knowledge and development of biodiversity enterprises; Importance of People's participation and resources management.

Grassroots Innovation:

Innovation: Basics, understanding the need and importance with examples (various fields); History of Research with relevant examples; Creativity: concept and Scientific Approach; Rights, Patents, Copyrights, and Royalty: definition, rules, examples; Out of box Thinking: Concept, types (lateral, rational and innovative thinking); Innovation for building entrepreneurship: comparison between international and national level innovators, identification of innovations for career building.

Unit II, III & IV: Literature Review (45L)

Through interdisciplinary perspectives, students will develop the skills and confidence to improve their understanding of the world around us, and work towards developing sustainable solutions to today's environmental and social problems, drawing on ecology, bio- and geo-science to understand earth-system processes, and the social sciences and humanities to understand societal impacts.

With a range of module options, students can explore their interests and develop career ambitions. Building skills in the collation, analysis, synthesis and presentation of interdisciplinary data, students will have greater chances of placement for a range of jobs or research paths.

Students can select any module for literature review from the full range of options taught in the Department during Semester III and/ IV, allowing them to focus on a particular period, region on specialist area.

PRACTICAL: PSLSCEBTP403: Environmental Sustainability and Innovation

1. Practical Training on identification of innovations for career building:

This would include exposing students to conceptions of innovation in career development that would include: (a) initiating service, (b) developing demographic-based programmes, (c) professionalising the sector to exploiting cross-sectoral synergies.

The findings would give students a more profound understanding of critical aspects that may have an important role in improving innovation in career development. A brief report on this aspect will be prepared by each student or collectively (in groups- whichever is appropriate) based on which, examination and evaluation would be carried out.

2. Writing a Research Paper:

The students would be trained in writing a research paper in a standard scientific journal that fulfils all the norms of accreditation by National and International bodies such as UGC, Scopus, etc.

Training will include (1) Selection of a subject/s (multiple); (2) Narrow the topic; (3) State/ finalise tentative objective; (4) Forming preliminary bibliography; (5) Preparation of a working outline; (6) Making notes; (7) Preparation of outline of the paper; (8) Writing rough draft; (9) Edit the draft paper; and (10) Write the final draft.

A detailed survey of the relevant works done by other researchers in the domain would be conducted by the student. While doing this, the student is expected to refer to at least 50 recently published (last 10 years) research papers published in reputed Journals accredited by National and International bodies (such as UGC, Scopus), in addition to textbooks and web links in the relevant topic.

The above-said process will be monitored by the supervising Teacher/ Mentor.

REFERENCES:

1. Bio-mimicry: Innovation Inspired by Nature (1997) by Janine Benyus.
2. Cradle to Cradle: Remaking the Way We make Things (2002) by William McDonough and Michael Braungart.
3. Basic Environmental Technology. J.A. Nathanson.
4. Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value and Build Competitive Advantage (2006) by Daniel Esty and Andrew Winston.
5. Igniting Inspiration: A Persuasion Manual for Visionaries (2008).
6. Just Good Business: The Strategic Guide to Aligning Corporate Responsibility and Brand (2008), by Kellie McElhaney.
7. Natural Capitalism: Creating the Next Industrial Revolution (1999).
8. The Truth About Green Business (2009) by Gil Friend.
9. Our Choice: A Plan to Solve the Climate Crisis (2009) by Al Gore.
10. Beautiful and Abundant (2010) by Bryan Welch.
11. The HIP Investor: Make Bigger Profits by Building a Better World (2010), by Paul Herman.

PAPER PSLSCEBTT404: APPLIED ENVIRONMENTAL BIOTECHNOLOGY- II & INTERNSHIP/ PROJECT

Unit I: Abatement technologies for detrimental effects of climate change (15 Hours) [Hybrid mode- online & offline]

Role of AI in waste and negative changes on environment due to climate change; Pneumatic bins, carrier pipes & vehicles; Kiosks for e-waste, biomedical waste, support system to the people affected because of pollution and other adverse processes; Role of Solar energy in the subject; Role of plasma technology.

[Students will be involved in Seminars/ and Presentations in Groups on the themes stated above. They will also undergo written examination and evaluation process, as prescribed for other core/ skill based Units.]

Unit II, III & IV: Internship/ Project (Total 45 Lectures)

Students will have an option to undergo internship (if they choose to do so) and could continue the work undertaken in Semester III during Literature Review as a Project with respective Mentor/ Supervising Teacher.

Internship

The syllabus proposes an internship for about 6 weeks to 8 weeks to be done by a student. **Interning organization/s identified by the Department would be allotted to the Intern (student) who would** formally work as a full-time Intern with the Organisation allotted to him/ her during the internship period. The student would be subjected to an internship evaluation with proper documentation of the attendance and the type of work he/ she has carried out in the organization allotted to him/ her. Official Certificate (including seal of the Organisation) of successful completion of internship will be issue by the Supervisor (from respective Organisation) for which a standard format will be defined by the Department.

OR

Project:

The syllabus proposes project implementation as part of the Semester IV. The student is expected to submit the proposal and implement the same in the Semester IV. In addition, experimental setup, analysis of results, comparison with results of related works, conclusion, and prospects will be part of the project implementation. A student is expected to make a project implementation report and appear for a project viva. He or she needs to spend around 105 hours for the project implementation, which fetches 6 credits.

PRACTICAL: PSLSCEBTP404: Internship/ Project

Internship:

An internship offers an environment for the student to apply what he or she has learned in the classroom in a real-world setup. It also equips the student with the technical and non-technical skills required by the industry. An organization, in turn, gets an opportunity to understand and appreciate the curriculum of the Program and will be in a position to offer constructive feedback on the course and industry requirements. The Department Faculty will also get first-hand exposure to understand the industry/ collaborating organisation and the type of work they do, which will help to improve the pedagogy and delivery.

For Skill-based subjects and internship, students in a group of 3-5 will be assigned to:

- Organisations such as Municipal Corporations of Mumbai, Navi Mumbai, Thane, etc;
- Environmental laboratory, e.g., Envirocare, Thane;
- Environmental Consultancy and Legal Services Company, e.g., Mahabal Enviro Engineers Pvt. Ltd., Thane
- Common Effluent Treatment Plant (CETP), Turbhe, Navi Mumbai;
- Instrumentation companies, e.g., Labindia, Thane and other similar companies; or
- Chronobiology laboratory at International Institute of Sleep Sciences, Thane.

The Student will not undergo internship in the parent Department (University Dept. of Life Sciences). To ensure the rigour of the MSc Program, the Student will be provided with a Faculty Mentor by the parent Department and an Industry Mentor (to be provided by the Organization where the Student would be interning with. Industry Mentor will ensure that the requirements of the Department and the demands of the Project are done by the Internee. The faculty Mentor will be the overall in-charge of the internship. He or she could evaluate the quality of the internship in a uniform manner across all students and within the framework of the Program.

Documentation: Student will develop two documents as a part of internship.

On-line Diary: This ensures that the student updates daily activity, which could be accessed by both the mentors. Daily entry will consist of a short write-up (up to a maximum of 4-5 sentences) giving a brief account of the learning/ activities/ interaction taken place on a particular day. The Faculty Mentor will monitor the entries in the diary regularly.

Internship Report: Student is expected to make a report based on the internship he or she has undergone in an organization. It should contain the following:

The Internship Report: Student at the end of his/ her internship, would prepare a detailed report of the activities carried out in the following Proforma:

- **Title:** A suitable title that would give clear idea about type of work/ assignment the student has carried out during internship period.
- **Name, Type and Description of the Organization:** A brief description of the Organization where the student has interned will follow.
- **Description of the activities assigned to the Student by a specific Division/ Section of the Organisation where the intern has worked:** This should give an idea about the type of activity a fresh employee is expected to do in that Division/ Section of the Organization.
- **Description of work allotted and done by the intern:** A detailed description of the work allotted, and actual work performed by the intern during the internship period. It shall be the condensed and structured version of the daily report mentioned in the online diary.
- **Self-assessment:** A self-assessment by the intern on what he or she has learned during the internship period. It shall contain both technical as well as interpersonal skills learned in the process.

The internship report needs to be submitted to the External Examiner at the time of the University examination.

Interaction between Mentors and the Student:

To ensure smooth conduct of the internship a few meetings (as and when required) involving the Intern, Industry Mentor, and the faculty Mentor will be scheduled as a mid-term review. The meeting can preferably be online to save time and resources. The meeting ensures the synergy between all stakeholders of the internship. A typical meeting can be of around 15 minutes where at the initial stage the intern brief about the work and interaction goes for about 10 minutes. This can be followed by the interaction of the mentors in the absence of the intern. This ensures that issues between the intern and the organization, if any, are resolved amicably.

Internship workload (to be allotted) to Dept. Faculty (Mentor) against his involvement in Internship/ Project:

Every Student is provided with a Faculty Member as a Mentor. The Dept. Faculty (Mentor), who would be supervising research of a few Students (2-7, depending on the total number of Students in Part II) will be an overall in-charge of the internship of the student. The Mentor would constantly monitor work progress of the Intern by regularly checking the On-diary, interacting with the Industry Mentor, and guiding Student on Report writing, etc.

Considering the time and efforts of the Dept. Faculty (Mentor) involved in Internship/ Project, he/ she shall be provided workload of 3 hours/ week.

OR

Project

Guidelines for Project Implementation in Semester - IV

- A student is expected to devote at least 3 to 4 months of effort to the implementation.
- Students should submit a detailed project implementation report at the time of viva.

Guidelines for Documentation of Project Proposal in Semester –IV

A student should submit a project implementation report with the following details:

- **Title:** Title of the project.
- **Objective:** A detailed objective of the proposal (based on the Literature Review conducted by the Student in Semester III/ to be freshly defined).
- **Related works:** A detailed survey/ documentation of the relevant works done by others in the domain. The student is expected to refer to at least 15 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.
- **Methodology:** A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software, and data to be used.
- **Implementation details:** A description of how the project has been implemented.
- **Experimental setup and results:** A detailed explanation of how experiments were conducted, what software was used, and the results obtained. Details like screenshots, tables, and graphs can come here.
- **Analysis of the results:** A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc., may be part of this.
- **Conclusion:** A conclusion of the project performed in terms of its outcome
- **Future enhancement:** A small description of what enhancement can be done when more time and resources are available

The project documentation needs to be signed by the teacher in charge and head of the Department. Student should also attach the certified copy of the Internal Evaluation Report (standard format to be provided by the Dept.) at the time of Project evaluation and viva as part of the University examination.