

General conditions:

Eligible students: *Bachelors' degree in Engineering or Technology in Biotechnology/Civil/Chemical engineering /Food Technology & Biochemical Engineering or Bachelor's degree in Pharmacy or 2 year Master of Science degree in Environmental Science/Biotechnology/Physics/Chemistry/Mathematics/Geology. All Science candidates should have Mathematics in undergraduate level. Selection will be on the basis of a written test. Preference will be given to GATE score holders.*

Scholarship: *Engineering /Technology/Pharmacy graduates and Science post graduates with valid GATE score are eligible to avail monthly stipend as per MHRD guidelines.*

Fees: *Rs. 2000/- per month in accordance with other postgraduate M.E./M. Tech. courses of Jadavpur University.*

Intake: *18 (Including reserved seats as per University rules)*

Master of Technology (Environmental Biotechnology)

First Semester

Theoretical courses	Subjects		Periods/Weeks		Marks		Credit Points
	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	
Departmental/ Specialization basket	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	
Paper I	PG/EBT/T/	Modern Biology and Biochemical Engineering	3		100		3
Paper II	PG/EBT/T/	Environmental Pollution	3		100		3
Paper III	PG/EBT/T/	Pollution Control Strategies	3		100		3
Note: Students have to select 3 subjects from the departmental/specialization basket, i.e., one subject each from the given list, Paper I, Paper II and Paper III							
Interdisciplinary basket	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	Credit Points
Paper IV	PG/EBT/T/	Introduction to Environmental Science	3		100		3
Paper V	PG/EBT/T/	Natural Resources	3		100		3
Paper VI	PG/EBT/T/	Biodiversity Conservation and Management	3		100		3
Note: Students have to select 2 subjects from the interdisciplinary basket, i.e., one subject each from the given list, Paper IV and Paper V							
Sessional Courses	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	Credit Points
Sessional 1	PG/EBT/S/	Water and Air Quality Measurements		4		100	3
Sessional 2	PG/EBT/S/	Environmental Microbiology		3		100	3
			18	7	600	200	24

Total periods per week = 25

Total marks = 800

Second Semester

Theoretical courses	Subjects		Periods/Weeks		Marks		Credit Points
	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	
Departmental/ Specialization basket	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	
Paper VII	PG/EBT/T/	Wastewater Treatment and Bioremediation	3		100		3
Paper VIII	PG/EBT/T/	Solid and Hazardous Waste Management	3		100		3
Paper IX	PG/EBT/T/	Environmental Impact Assessment and Laws	3		100		3
Note: Students have to select 3 subjects from the departmental/specialization basket, i.e., one subject each from the given list, Paper VI, Paper VII and Paper VIII							
Interdisciplinary basket	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	Credit Points
Paper X	PG/EBT/T/	Elective*	3		100		3
Note: The students have the freedom to choose one subject from the list under Paper X.							
Sessional Courses	Subject code	Subject Name	Lecture	Sessional	Examination	Sessional	Credit Points
Sessional 1	PG/EBT/S/	Wastewater Treatment Process Operations & Field Work		3		100	3
Sessional 2	PG/EBT/S/	Term Paper Leading to Thesis		3		100	3
			12	6	400	200	18

* For list of electives please see next page

Total periods per week = 18 Total marks = 600

Third and fourth Semesters

Courses	Subject Code	Subject	Periods/Weeks	Marks		Credit Points
				Examination	Sessional	
1	PG/EBT/TH/	Thesis work	16		300	12
2	PG/EBT/VV/	Viva Voce			100	
			16		400	12

Total periods per week = 16

Total marks = 400

List of electives:

1. Biosensors for Environmental Monitoring
2. Environmental Health and Toxicology
3. Green Manufacturing Technologies
4. Safety Engineering
5. Biometallurgy
6. Biofuel Technology

SYLLABUS OF MASTER OF TECHNOLOGY IN ENVIRONMENTAL BIOTECHNOLOGY

FIRST SEMESTER

Category: Departmental/Specialization basket

PG/EBT/T/ Modern Biology and Biochemical Engineering

Microbial diversity. Prokaryotic and eukaryotic systems. Chemical construction of a cell. Cell nutrients. Nature of the gene and genome. Expression of genetic information (from transcription to translation). Control of gene expression. DNA replication and repair. Recombinant DNA technology. Manipulation of gene expression in prokaryotes. Genetic engineering of biodegradative pathways. Basic concepts of bioenergetics, enzymes, metabolism, respiration, photosynthesis. Batch and continuous cultures. Stoichiometry of microbial growth and product formation. Aeration and agitation in bioreactors. Operating bioreactors for suspension and immobilized cultures. Selection, scale-up, instrumentation and control of bioreactors. Biochemical engineering aspects of wastewater treatment. Bioinformatics. Nanobiotechnology. Life in extreme environments.

Recommended books: (1) Concepts in Biotechnology by Balasubramanan (Universities Press) (2) Environmental Biotechnology-a biosystems approach by Daniel Vallero (Academic Press) (3) Bioprocess Engineering by Shuler and Kargi (Prentice Hall India) (4) Biochemical Engineering Fundamentals by Bailey and Ollis (Mc Graw Hill)

PG/EBT/T/ Environmental Pollution

Air pollutants-particulates, hydrocarbons, oxides of carbon, sulphur, nitrogen, organic pollutants. Water and soil pollutants-suspended and floating solids, organic (pesticides, PCBs, halogenated aliphatics, phenols etc.), metals and inorganics, pathogens. Noise pollution-sources, traffic noise. Measurement of air pollutants. Measurement of water/soil pollutants. Modern analytical techniques. Radiation, radioactive waste and electromagnetic pollution.

Recommended books: (1) Environmental Chemistry by Manahan, CRC Press (2) Air Quality by Godish, Lewis Publishers (3) Automobile Pollution by Kush, Ivy Publishing

PG/EBT/T/ Pollution Control Strategies

Pollution control technology as an interdisciplinary approach. Process integrated pollution control in chemical industry. Unit operations/processes for water and wastewater treatment. Sludge treatment and disposal. Wastewater reuse. Control devices for particulate and gaseous air pollutants. Gravitational settling chambers, centrifugal collectors, wet collectors, fabric

filters, electrostatic precipitators. Adsorption, absorption, condensation, combustion, automobile emission control.

Recommended books: (1) Environmental Engineering by Peavy, Mc Graw Hill (2) Handbook of Air Pollution Technology by Calvert and Englund (John Wiley and Sons)

Category: Interdisciplinary basket

PG/EBT/T/ Introduction to Environmental Science

Holistic concept of the environment. Concept of the biosphere. Cycling of matter in the biosphere. Concept of biodiversity. Human issues. Socio-economic aspects. Environmental degradation. Global environmental issues: climate change, energy and environment and other issues (in discretion of the teacher) vis-à-vis Indian scenario. Role of engineers/technologists in environmental protection and management.

Recommended books: (1) Environmental Science by Santra (Ne Central Book Agency) (2) Environmental Issues in India by Rangarajan (Pearson Longman)

PG/EBT/T/ Natural Resources

Natural water resources. Hydrological cycle. Lakes, streams, marine water. Concept of ecological flow. Ground water. Fluid dynamics of surface and ground water. Dissolved matter in natural waters. Water quality. Soil: its composition, physico-chemical properties, origin of soil, environmental classification of soil. Classification of land, land-use, land conservation. Mineral resources. Geographical distribution and status of forests: global and national. Wildlife action plan in India. Management of forests and resources.

Recommended books: (1) Water Technology, An Introduction for Environmental Scientists and Engineers (Butterworth and Heinemann) (2) Soil Microbiology, Ecology and Biochemistry by Paul (Academic Press)

PG/EBT/T/ Biodiversity Conservation and Management

Convention on biological diversity. Current status of biodiversity-international and national. Strategies for preservation of biodiversity. Ex-situ and In-situ conservation. International and national scenarios of conservation efforts. Bioprospecting and biotechnological utilization of biodiversity.

Recommended books: (1) Biodiversity under threat by Hester and Harrison (RSC Publishing) (2) Biodiversity and Environment by Arvind Kumar (APH Publishing) (3) Environmental Conservation by Asish Ghosh (APH Publishing)

*Category: Sessional courses***PG/EBT/S/ Water and Air Quality Measurements**

Determination of water quality parameters from different sources: TDS, pH, conductivity, sodium, potassium, iron, acidity, alkalinity, hardness, DO, chloride, sulphate. Arsenic content in groundwater. Determination of wastewater parameters: Suspended solids, dissolved solids, COD, BOD, TKN, phosphate, oil and grease. Determination of air pollution parameters : SPM, RPM, NO₂, SO₂, settleable dust

Recommended book: (1) Standard Methods for the Examination of Water and Wastewater (American Public Health Association)

PG/EBT/T/S Environmental Microbiology

Laboratory methods used to count the micro-organisms present in soil and understand the limitation of each method. Characterization of various micro-organisms that inhabit the soil. Laboratory testing used for the detection members of Coliform bacteria in drinking and sewage water. Microbiological degradation of chemical pollutants. Microbiological production of bioplastics. Measurement of microbial metabolic activity. Enzyme assays.

Recommended books: (1) Standard Methods for the Examination of Water and Wastewater (American Public Health Association) (2) Microbiology-a Laboratory Manual by Cappuccino (Pearson Education)

SECOND SEMESTER*Category: Departmental/Specialization basket***PG/EBT/T/ Wastewater Treatment and Bioremediation**

Process selection. Suspended growth biological treatment processes. Attached growth and combined biological treatment processes. Tertiary treatment processes. Anaerobic suspended and attached growth biological treatment processes. Growth linked biodegradation. Kinetics of biodegradation. Concept of bioavailability. Recalcitrant molecules. Effect of chemical structure on biodegradation. Predicting products of biodegradation. Cometabolism. Inoculum development. In situ and soil phase bioremediation technologies. Ex situ and bioreactor based remediation technologies. Biodegradation of air pollutants.

Recommended books: (1) Wastewater Engineering-Treatment and reuse by Metcalf and Eddy (Tata Mc Graw Hill) (2) Industrial Wastewater-Management, Treatment and Disposal by Water Environment Federation (Mc Graw Hill) (3) Microbial Ecology by Atlas and Bartha (Pearson Education)

PG/EBT/T/ Solid and Hazardous Waste Management

Solid waste generation, on-site handling, storage and processing, collection of solid wastes, transfer and transport, processing techniques, disposal. Microbiology of solid waste landfills. Composting. Microbial pathogens in landfills. Biodegradability of synthetic chemicals. Hazardous waste characteristics. Inventory of hazardous wastes. Risk assessment. Hazardous wastes rules: Basel Convention, MARPOL Convention. Treatment and disposal of hazardous wastes (thermal destruction, containment). Radioactive hazardous wastes.

Recommended books: (1) Environmental Management of Solid Waste by Salomons (Springer-Verlag) (2) Solid Waste Management and The Environment by Neal and Schubel (Prentice Hall)

PG/EBT/T/ Environmental Impact Assessment and Laws

Relation between development and environment. Sustainable development and carrying capacity. Screening, scoping. Baseline studies and monitoring. Impact analysis. Public participation. Methodologies. Environmental Protection Act, 1986, Water Prevention and Control of Pollution Act, 1974, Water Prevention and Control of Pollution Cess Act, 1974, Air Prevention and Control of Pollution Act, 1981, Hazardous Wastes (Management and Handling) Rules. International environmental laws.

Recommended books: (1) Introduction to Environmental Impact Assessment by Glasson (Taylor and Francis Group) (2) Environment Impact Assessment by Shrivastava (APH Publishing) (3) Environmental Laws by Chatterjee (Deep & Deep Publications)

Category: Interdisciplinary basket

Elective theory papers (At least three of the six elective papers will be offered and the student has to select one)

PG/EBT/T/ Biosensors for Environmental Monitoring

Basic concepts: Principles of detection, photometric, electrochemical, ion-channel switch, piezoelectric. Signal transduction. Types of transducers. Surface attachment of the biological elements. Multianalyte detection. Miniaturization. Data analysis and interpretation. Biosensors for pesticides and organics. Biosensors for metal contamination. Endocrine effect biosensors. BOD biosensors. Other applications. On-site applicable biosensors.

Recommended books: (1) Biosensors: A Practical Approach (The Practical Approach Series) by Jon Cooper and Tony Cass (Oxford University Press) (2) Biosensors for the Environmental Monitoring of Aquatic Systems: v. 5, Pt. J: Indicator Assays and Chemical Methods for Endocrine Disrupting Compounds in Wastewaters Volume editors Damia Barcelo and Peter-

Diedrich Hansen (Springer) (3) Smart Biosensor Technology George K. Knopf and Amarjeet Bassi (Publisher, NanoScience Works)

PG/EBT/T/ Environmental Health and Toxicology

Basic principles of toxicology-concepts in dose-response relationships. Acute, chronic and cumulative toxicity. Absorption, distribution and excretion of toxins, biotransformation of foreign chemicals, organ specific toxicity, reproductive toxicology and teratology. Cancer formation-progressive stages, toxicity of carcinogens and mutagens. Toxic metals and metalloids-effects on health. Air pollution-effects on the human system, water borne diseases and their control. Functional units and activities of occupational health services-occupational and work related disease-Levels of prevention of diseases. Notifiable occupational diseases.

Recommended books: (1) Goodman and Gillmann's Pharmacological basis of therapeutics (2) Clayton & Clayton, Patty's "Industrial Hygiene and Toxicology", Vol. I, II and III, Wiley Inter Science (3) Environmental Toxicology by Wright and Wellbourne (Cambridge University Press).

PG/EBT/T/ Green Manufacturing Technologies

Sustainable development. Use of renewable resources. Recycling of waste products. Energy conservation. Cleaner product design. Life cycle approaches to product design. Cleaner process design. Substitution of conventional chemical processes by bioprocesses. Handling of toxic materials. Regulatory, social and business environment for green manufacturing. Metrics and analytical tools. Green supply chains. Present state of green manufacturing. Case studies.

Recommended book: Green manufacturing: Fundamentals and applications by David Dornfield (Springer)

PG/EBT/T/ Safety Engineering

Approach to Safety. Causes of Accidents. Accident Analysis and Control. Techniques used in Safety analysis. Safety Management and Organization. Risk Management. Training. Human Behavioral Approach in Safety. Risk Assessment. Uncertainty Analysis. Components of safety audit. Review of inspection, remarks by government agencies, consultants, experts. Perusal of accident and safety records. Formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor.

Recommended books: (1) Reliability and safety engineering by Ajit Kumar Verma, , Srividya Ajit, and Durga Rao Karanki (Springer) (2) Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Mumbai (3) Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York

PG/EBT/T/ Biometallurgy

Microbial ecology. Extremophiles. Physiological and biochemical studies of mining microorganisms metal recovery bioprocesses Bioleaching, biobenefeciation. Bioleaching operations: from mineral deposits, wastes and sludges. Biosorption and bioaccumulation. Analytical techniques. Electron transfer between biofilms and metals. Genomics for biomining. Metabolism peculiarities in bacteria of genus *Sulfobacillus*. Case studies (examples): Uranium mining rehabilitation, removing sulfur from oil shale, microbial leaching of metals from printed circuit boards.

Recommended books: (1) Biohydrometallurgy: A Meeting Point Between Microbial Ecology, Metal Recovery Processes and Environmental Remediation by Marisa R. Viera, Eduardo L. Tavani, Maria A. Giaveno, Teresa L. Lavalla, Trans Tech Publishing (2) Biohydrometallurgy and the Environment Toward the Mining of the 21st Century (Process Metallurgy), Elsevier Science (3) Biohydrometallurgy (Environmental Biotechnology) by Rossi G (Mc Graw Hill)

PG/EBT/T/ Biofuel Technology

Harvesting Energy From Biochemical Reactions. Microbial Modeling of Biofuel Production Bioethanol: Utilizable biomass, biochemical engineering and bioprocess management. Biodiesel: Chemistry and production process, use of macro and microalgae. Biohydrogen: Technologies and future trends. Microbial Fuel Cells. Economics: market forces and cost models.

Recommended books: (1) Biofuels Engineering Process Technology by Caye Drapcho, John Nghiem, Terry Walker (Mc Graw Hill) (2) Biofuels : Biotechnology, Chemistry, and Sustainable Development by David M. Mousdale (CRC Press) (3) The Complete Book on Jatropha (Bio-Diesel) with Ashwagandha, Stevia, Brahmi & Jatamansi Herbs (Cultivation, Processing & Uses) by NIIR Board of Consultants & Engineers (India),(Eastern Book Corporation).

Category: Sessional courses

PG/EBT/S/ Wastewater Treatment Process Operations and Field Work

Students will perform a complete wastewater treatment process operation in a model aerobic process (activated sludge) or rotating disc biological contactor. They will record data for the entire period of operation and then present it along with their own inferences.

Students will visit sites such as wastewater treatment plant, solid waste disposal site, reserve forests and such other places as may be decided from time to time. They will submit a field report incorporating their own observations and comments which has to be presented in a seminar.

Recommended book (1) Water and Wastewater Technology by Hammer and Hammer (Prentice Hall India)

PG/EBT/S/ Term Paper Leading to Thesis

3RD AND 4TH SEMESTERS

Category: Sessional courses

PG/EBT/S/ Thesis

Each student will devote full time in the third and fourth semesters on a thesis/project on an assigned research problem of design/development/process operation work under the supervision of a faculty member or an external supervisor outside of Jadavpur University. He/She will present a thesis/project report at the end of the fourth semester which will be evaluated by a board of examiners consisting of the supervisor and the external examiner. The evaluation of the thesis will be followed by a viva-voce in front of faculty members and other post graduate students.

PG/EBT/S/ Viva-voce