BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

WORK INTEGRATED LEARNING PROGRAMMES

COURSE HANDOUT

Academic Term	Second Semester 2020-2021
Course Title	Biological Treatment Principles and Design for Wastewater Systems
Course ID No.	SSTM ZG523
Lead Instructor	P. SANKAR GANESH
Instructor(s)	Ramesh Babu Adusumalli

Course Modules

Module No	Module Title	Objectives
1	Introduction	To get a general overview of aerobic and anaerobic biological treatment processes currently being used in wastewater treatment plants; Understand the role of microorganisms in wastewater treatment
2	Microbial physiology and metabolism	Composition and classification of microorganisms and microbial metabolism and bacterial growth
3	Nutrient cycles & Microbial Ecology	Carbon and oxygen cycles; Nitrogen, sulphur and iron cycles; Understanding the concepts of Nitrification; denitrification; dephosphorylation and their role in nitrogen and phosphorous removal; Environments and microenvironments, Microbial ecology of nitrogen and phosphorus removal, Filamentous growth and sludge bulking,
4	Wastewater microbiology and water purification	Wastewater treatment; Public health and water quality; water borne diseases; Sanitary analysis of water
5	Bioremediation	Heavy metal transformation, biodegradation of petroleum, xenobiotics; Microbial leaching of ores;

7	Biological treatment: suspended growth processes and design of the systems	Introduction to activated sludge process and sequential batch reactors, processes for BOD removal and nitrification, denitirification, phosphorous removal and membrane biological reactors
8	Biological treatment: attached growth and combined biological treatment processes	To study trickling filters, rotating biological contactors and fluidized bed reactors

Text Book(s)

T1	Metcalf and Eddy, Wastewater engineering-treatment and reuse, tata Mc-Graw Hill edition

Reference Book(s) & other resources

R1	Weismann U, Choi I S and Dombrowski E, Fundamentals of Biological wastewater treatment, Wiley-VCH, 2007
R2	Madigan et al, Brock Biology of Microorganisms, Pearson International Edition
R3	Published case studies; Research papers from different journals & Internet

Module 1: Introduction

Module No	Title	Ref
1.1 (Session 1)	Sewage; Types of wastewater treatment; Treatment process & purposes; Objectives of Biological treatment; Basic requirements of biological treatment process; Types of biological processes for wastewater treatment	Textbook Chap 7.1 and lecture slides

Module 2: Microbial physiology and metabolism

Module No	Title	Ref
2.1 (Session 2)	Role of microorganism in wastewater treatment; Cell structure and composition; Characteristics of Prokaryote & Eukaryote cells; DNA, RNA & Ribosomes; Gene Expression/	Textbook Chap 7.2 and lecture slides

	Protein Synthesis; Microbial Metabolism; Carbon & energy Sources; Nutrients & Growth Factors; Bacterial Growth, Energetics and Decay; Bacterial Reproduction; Bacterial Growth Patterns in a Batch Reactor; Bacterial Growth and Biomass Yield; Measuring Biomass Growth	
2.2 (Session 3)	Estimating cell yield and oxygen requirements; Estimating biomass yield from bioenergetics; Biomass decay; Observed versus Synthesis Yield; Microbial Growth Kinetics; Rate of utilization of soluble substrates;	Textbook Chap 7.2 and lecture slides

Module 3: Nutrient cycles & Microbial Ecology

Module No	Title	Ref
3.1 (Session 4)	Biogeochemical Cycles; Nutrient cycles; Carbon Cycle; Photosynthesis; Methanogenesis; Redox cycle for Carbon; Coupled nutrient cycles; Nitrogen cycle; Nitrogen Fixation; Denitrification;	R2 Chap 24 and lecture slides
3.2 (Session 5)	Ammonification; Nitrification; Redox cycle for Nitrogen; Annamox; Sulfur cycle; Hydrogen Sulfide and Sulfate Reduction; Sulfide and Elemental Sulfur Oxidation–Reduction; Organic Sulfur Compounds; Redox cycle for Sulfur; Iron cycle; Bacterial Iron Reduction; Ferrous Iron and Pyrite Oxidation at Acidic pH; Phosphorus cycle; Oxygen cycle	R2 Chap 24 and lecture slides
3.3 (Session 6)	Microbial Ecology Levels-of-Organization Hierarchy, Environments and microenvironments, Biological wastewater treatment & microbial ecology, Molecular insights into wastewater microbiology: FISH, SIP, Isotope array, Microelectrodes, Importance of	R2 Chap 23 and lecture slides

	microbial ecology in WWTPs, Microbial ecology of nitrogen removal, Nitrification, Anammox, Microbial ecology of phosphorus removal, Biological Phosphorus Removal, Filamentous growth and sludge bulking, Genomics of wastewater-relevant microorganisms, Wastewater microbial ecology	

Module 4: Wastewater microbiology and water purification

4.1 (Session 8)	Classification of micro-organisms	Textbook Chap 7.2; Chap22 (R2)
4.2 (Session 9)	Microbial ecosystems	Chap 23 (R2) and lecture slides
4.3 (Session 9)	Microbial environments and microenvironments	Chap23 (R2) and lecture slides

Module 5

Module No	Title	Ref
6.1 (Session 12)	Wastewater microbiology and water purification	Textbook Chap 8.2 and lecture slides
6.2 (Session 13)	Public health and water quality; water borne diseases	Chap 23 (R2) and lecture slides
6.3 (Session 14)	Sanitary analysis of water	Chap 23 (R2) and lecture slides

Module 6

Module No	Title	Ref
5.1 (Session 10)	Bioremediation	Textbook Chap 8.2 and lecture slides
5.2 (Session 11)	Microbial leaching of ores; Heavy metal transformation, biodegradation of petroleum, xenobiotics	Textbook Chap 7.2 and lecture slides

Module 7

Module No	Title	Ref
7.1 (Session 15)	Introduction to Activated Sludge Process (ASP) & Sequential Bioreactors, Process design considerations, Process control and Operational problems	Textbook Chap 8.1-8.4
7.2 (Session 15)	Nutrient removal processes in suspended growth processes and selection and design of physical facilities	Textbook Chap 8.5-8.7
7.3 (Session 16)	Biological treatment with membrane separation- Process description, Design of Membrane Biological Reactors, & Membrane fouling control	Textbook Chap 8.9-8.10

Module 8

Module No	Title	Ref
8.1 (Session 17)	Introduction to trickling filters and rotating biological contactors, process limitations, and process design considerations	Textbook Chap 9.1-9.3
8.2 (Session 18)	Introduction to fluidized reactor systems, Design principles and case studies	Textbook Chap 9.4-9.6

Evaluation Scheme:

	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Assignment / Quiz	Online	-	15%	February 1-15, 2021
EC-2	Mid-Semester Test	Closed Book	2 hours	35%	Sunday, 07/03/2021 (AN) 2 PM - 4 PM
EC-3	Comprehensive Exam	Open Book	3 hours	50%	Sunday, 02/05/2021 (AN) 2 PM - 5 PM

Syllabus for Mid-Semester Test (Closed Book): Topics in Session Nos. 1 to 9

Syllabus for Comprehensive Exam (Open Book): All topics (Session Nos. 1 to 18)

Important links and information:
Elearn portal: https://elearn.bits-pilani.ac.in

Students are expected to visit the Elearn portal on a regular basis and stay up to date with the latest announcements and deadlines.

Contact sessions: Students should attend the online lectures as per the schedule provided on the Elearn portal.

Evaluation Guidelines:
1. EC-1 consists of either two Assignments or three Quizes. Students will attempt them through the course pages on the Elearn portal. Announcements will be made on the portal, in a timely manner.

2. For Closed Book tests: No books or reference material of any kind will be permitted.

3. For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.