DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015, TAMIL NADU, INDIA
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Course Code	**:**	CE702
Title of the Course	**:**	Biological Process Design for Wastewater Treatment
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in wastewater and its treatment
Contact Hours, Type of Course	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

1. To learn the fundamentals of process kinetics and bioreactors
2. To study about various biological treatment processes and its operations for the wastewater treatment
3. To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors
4. To explain the design principles and operational problems involved in various biological treatment processes

Course Content

Constituents of Wastewater - Sources - Significant Parameter - Fundamentals of Process Kinetics, Zero Order, First Order, Second Order Reactions, Enzyme Reactions - Bio Reactors - Types, Classification, Design Principles - Design of Wastewater Treatment Systems - Primary, Secondary and Tertiary Treatments - Evaluation of Biokinetic Parameters - Activated Sludge and its Process - Modifications, Biological Nitrification and Denitrification - Attached Growth Biological Treatment Systems - Trickling Filters - Rotating Biological Contactors - Waste Stabilization Ponds and Lagoons - Aerobic Pond, Facultative Pond, Anaerobic Ponds - Polishing Ponds, Aerated Lagoons - Anaerobic Processes - Process Fundamentals - Standard, High Rate and Hybrid Reactors, Anaerobic Filters- Expanded /Fluidized Bed Reactors - Upflow Anaerobic Sludge Blanket Reactors - Expanded Granular Bed Reactors - Two Stage / Phase Anaerobic Reactors - Sludge Digestion, Sludge Disposal.

References

1. Benefield, L.D. and Randall C.W., Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1989.
2. Grady Jr. C.P.L and Lin H.C., Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.
3. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.
4. Arceivala, S. J. and Asolekar, S. R., Wastewater Treatment for Pollution Control, 3rd Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006.

Course outcomes

At the end of the course student will be able
1. to describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants
2. to design the biological reactors based on biokinetics
3. to select appropriate processes for specific applications, and have some knowledge of practical design considerations
4. to execute and asses the performance of bioreactors in laboratory scale

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COURSE OUTLINE

Course Title	Biological process design for wastewater treatment		
Course Code	CE702	**No. of Credits**	4
Department	Civil Engineering	**Faculty**	Dr. S. T. Ramesh
Pre-requisites Course Code	-		
Course Coordinator(s)(if, applicable)	Dr. S. T. Ramesh		
Other Course Teacher(s) / Tutor(s)	-	**E-Mail**	stramesh@nitt.edu
Course Type	√ Core		
	Elective		
	Open Elective		
	Laboratory		

COURSE OVERVIEW

This course develops the fundamentals and applications of aerobic and anaerobic biological unit processes for the treatment of domestic wastewater. The principles of activated sludge, aeration, fixed film reactors, anaerobic treatment, solids handling and treatment and nutrient removal are presented. This course uses concepts from microbiology and the basic principles of stoichiometry, energetics, and microbial kinetics are used to support the design of biological unit processes. This course also familiarizes students with appropriate design criteria and the design process for wastewater treatment plants.

COURSE LEARING OBJECTIVES

The objective of the course is to:
1. To learn the fundamentals of process kinetics and bioreactors
2. To study about various biological treatment processes and its operations for the wastewater treatment.
3. To explain the design principles and operational problems involved in various biological treatment processes
4. To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors

COURSE OUTCOMES (CO)

Course Outcomes

After successful completion of the course, the students should be capable to :

CO1	to describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.
CO2	to design the biological reactors based on biokinetics
CO3	to select appropriate processes for specific applications, and have some knowledge of practical design considerations.
CO4	to execute and asses the performance of bioreactors in laboratory scale

Aligned Programme Outcomes(PO)

	1	2	3	4	5	6	7	8	9	10	11
CO1	H	L	L	M	L			M	L		
CO2	H	H	M	M		M					M
CO3	M	H	M	H	H	H	M			L	L
CO4		H	M	M	H	L			L		H

1. Scholarship of Knowledge	2. Critical Thinking
3. Problem Solving	4. Research Skill
5. Usage of modern tools	6. Collaborative and Multidisciplinary work
7. Project Management and Finance	8. Communication
9. Life-long Learning	10. Ethical Practices and Social Responsibility
11. Independent and Reflective Learning	

COURSE TEACHING AND LEARNING ACTIVITIES

Sl.No.	Week	Topic	Mode of Delivery
1.	2nd week of January 2018 **(4 Contact Hours)**	Wastewater, typical composition of wastewater, impact of untreated wastewater, types of wastewater, sources and quantities of wastewater - constituents of wastewater - physical and chemical characteristics - Biochemical oxygen demand - laboratory calculation of BOD - nitrification in the BOD test - components of total solids - chemical oxygen demand - Total organic carbon - nitrogen - phosphorus - fats, oils, waxes, and grease - surfactants - volatile organic compounds - microbiological characteristics - bacteria - viruses – protozoa	Lecture / Tutorial / Chalk & Talk / Power Point Presentation

2.	3rd week of January 2018 **(4 Contact Hours)**	Fundamentals of Process Kinetics, Reaction rate and Specific Reaction rates, Effect of Temperature -Zero order, First order, Second order Reactions- Enzyme reactions	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
3.	4th week of January 2018 **(4 Contact Hours)**	Reactor Analysis - Completely mixed batch reactor- Continuous flow stirred tank reactor, Plug flow reactor, Tracer Studies	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
	5th week of January 2018 **(3 Contact Hours)**	Introduction to design of ww system, Important Factors in Process Selection, Primary treatment system, Screening - Coarse Screens - Moving Screens - Common Operating Problems - Head loss in screens – Problem & Design of screen chamber	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
4.	1st week of February 2018 **(2 Contact Hours)**	Grit Removal - Aerated Grit Chamber - Operation and Maintenance - Design criteria for Grit Chamber, proportional weir, Design of Grit Chamber	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
5.	2nd week of February 2018 **(4 Contact Hours)**	Primary Sedimentation - Common Operating Problems - Sedimentation (Theory), Factors affecting, Design of circular & Rectangular sedimentation tank	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
6.	3rd week of February 2018 **(4 Contact Hours)**	Basic principles & Objectives of Biological treatment - Suspended growth vs. Fixed film biological treatment - Growth curve / Introduction to kinetics of ASP, Substrate limited growth / cell yield, Application of kinetics to Biological treatment - Evaluation of biokinetic parameters	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
7.	4th week of February 2018	**ASSESSMENT 1**	
8.	5th week of February 2018 **(3 Contact Hours)**	Suspended growth biological processes - Basic Process of Activated Sludge - Mean Cell Residence Time - Solids in Aeration Tanks - Sludge Volume Index - Food to Microorganisms Ratio - Organic Loading - Oxygen Requirements	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
9.	2nd week of March 2018 **(4 Contact Hours)**	Types Of Activated Sludge Process - Complete Mix Activated Sludge Process - Plug Flow Activated Sludge Process - Contact Stabilization Activated Sludge Process - Step Feed Activated Sludge Process - Extended Aeration Activated Sludge Process - Oxidation Ditch Activated Sludge Process - High Purity Oxygen Activated Sludge Process - Aeration systems - Design of Activated Sludge Process - Trouble Shooting in Activated Sludge Processes - Bulking - Floating sludge - Pinpoint floc - Ashing – Straggler floc - Foaming Biological Nitrification, Denitrification	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
10.	3rd week of March 2018 **(4 Contact Hours)**	Attached Growth Process - Components - Trickling Filter - Trickling Filter Process - Types of Trickling Filter - Filter media - Single Stage Trickling Filter- Two Stage Trickling Filter - Design of Trickling filter / Ecken felder / NRC / Rankines - Operation and maintenance - Disagreeable Odors from Filter - Ponding on Filter Media - Filter Flies (Psychoda) - Icing - Rotating Biological Contactors (RBC)	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
11.	4th week of March 2018 **(4 Contact Hours)**	Waste Stabilization Ponds - operation and maintenance - Lagoons - aerated lagoons - partial mix lagoons - operation and maintenance Anaerobic lagoons - process microbiology - operation and maintenance - facultative lagoons - operation and maintenance - polishing filter - limitations - lagoon process comparison Anaerobic processes – Process fundamentals - Two stage / phase anaerobic reactors - Standard, high rate and hybrid reactors - Anaerobic filters - Expanded / fluidized bed reactors - Upflow anaerobic sludge blanket reactors - Expanded granular bed reactors	Lecture / Tutorial / Chalk & Talk / Power Point Presentation

12.	5h week of March 2018 **(4 Contact Hours)**	Reasons for sludge treatment - Nature of Solids - Screenings Disposal - Grit Disposal - Skimmings Disposal - Composition of Sludge - Sludge Treatment Methods- Thickening - Gravity Thickening - Flotation Thickening - Centrifugation - Stabilization – Aerobic Digestion - Anaerobic Digestion - Process Indicators - Thermal Stabilization - Chemical Stabilization - Sludge Conditioning - Thermal Conditioning - Dewatering – Vacuum Filtration - Pressure Filtration - Centrifugation - Drying Beds - Sludge Lagoons Volume Reduction - Incineration - Wet Air Oxidation - Sludge Disposal - Disposal in Water - Disposal on Land - Soil Conditioning or Fertilizer - Composting	Lecture / Tutorial / Chalk & Talk / Power Point Presentation
13.	1st week of April 2018	**ASSESSMENT 2**	
14.	2nd week of April 2018 **(4 Contact Hours)**	Types of Wastewater Reuse - Reuse for Irrigation - Irrigation of Agricultural Crops - Irrigation of Landscape and Recreational Area - Domestic and Industrial Reuse - Industrial Reuse - Urban Applications - Groundwater Recharge - Benefits - Potential benefits of wastewater reuse - Factors driving further implementation of wastewater reuse	Lecture / Tutorial / Chalk & Talk / Power Point Presentation

COURSE ASSESSMENT METHODS

Sl. No.	Mode of Assessment	Week / Date	Duration	% Weightage
1.	Assessment 1	4th week of February 2018	60 Minutes	20%
2.	Assessment 2	1st week of April 2018	60 Minutes	20%
3.	Assessment 3 (Assignments / Group / Team Task Term paper / project / presentation)	5h week of March 2018	-	10%
4.	End Assessment	5th week of April 2018	180 Minutes	50%

Note:

1. Attending all the assessments (Assessment 1 to 4) is MANDATORY for every student.
2. If any student is not able to attend Assessment-1 / Assessment-2 due to genuine reason, student is permitted to attend the compensation assessment (CPA) with 20% weightage (20 marks).
3. At any case, CPA will not be considered as an improvement test.
4. Every student is expected to score minimum 40% (i.e., 40 marks) to pass the course. Otherwise the student would be declared fail and 'F' grade will be awarded.

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

1. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse, 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
2. Shun Dar Lin, Water and Wastewater Calculations Manual, McGraw-Hill Companies, Inc., 2007
3. NPTEL materials http://nptel.iitm.ac.in
4. MIT Open Courseware http://ocw.mit.edu /index.htm

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

The purpose of this survey is to find out from you about your learning experiences and your thoughts about the course. Your replies are very important to assist us in better serving our graduate students. Be assured that your comments will remain absolutely confidential and I will not be able to identify you from other participants.

- Direct feedback from the students by face-to-face meeting individually and as the class as a whole.
- Feedback from the students during class committee meetings
- Exit survey from the students at the end of the session through questionnaire

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

DISHONEST / PLAGIARISM means knowingly presenting another person's ideas, findings or work as one's own by copying or reproducing them without due acknowledgement of the source, with intent to deceive the examiner into believing that the content is original to the student. Plagiarism is a specific form of cheating which consists of the misuse of the published and/or unpublished works of others by misrepresenting the material (i.e., their intellectual property) so used as one's own work.

All of the following are considered plagiarism:

- turning in someone else's work as your own

- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)
- Failing to give credit via footnotes for ideas and concepts, date and information, statements and phrases, and/or interpretations and conclusions derived by another.
- Including references in the Bibliography that were not examined by the student.

Attendance

The attendance will be taken in all the contact hours. Students are encouraged to attend all the classes without absence. Also, the students are encouraged to participate in various co-curricular and extracurricular activities to enrich the academic / campus life. The percentage of attendance is calculated up to 3 days before the last working day in the respective session. The minimum attendance for appearing for the end semester examination is 75%. In some circumstances with reasonable cause for non-attendance, the students should inform the faculty within one week after their absence or feasibly in a week prior. In that case, the students will be given the opportunity to make up the missed classes or quiz or assignment. Those students, whose attendance falls below 75% but above 50% in a subject, shall attend mandatory classes after the closure of the attendance of the current session. Only those students who have completed the mandatory classes will be eligible and be permitted to appear for end semester examination.

The percentage of attendance in a subject shall be computed as:

(a) For calculation of attendance in normal cases:

$$\text{Percentage of Attendaance} = \frac{\text{Actual no. of classes attended}}{\text{Total no. of classes held till date of compiation of attendance}} \text{X } 100$$

This should be 75%for the student to appear for semester examinations.

(b) For calculation of attendance in case of prolonged illness and/or hospitalization with medical certificate:

$$\text{Percentage of Attendaance} = \frac{\text{Actual no. of classes attended}}{\text{Total no. of classes held till date of compilation of attendance} - \text{No. of classes held during the days of prolonged illness and or hospitilization}} \text{X } 100$$

Under any case, a student should have more than 50% attendance calculated as per (a) above to be eligible for appearing in end semester examination.

ADDITIONAL COURSE INFORMATION

1. All the students are advised to check their NIT-T webmail regularly to know the updates.
2. Drop box : envnitt@gmail.com
3. All the correspondence (schedule of classes / schedule of assessment / course material / any other information regarding this course) will be communicated through drop box / webmail.
4. Queries / Clarifications / Discussions (if required) may be E-mailed to me / contact me during 4.00 PM to 5.00 PM on Monday and Friday with prior intimation.

FOR APPROVAL

Dr. S. T. Ramesh	**Dr. Deendayal**	**Dr. K. Baskar**
Course Faculty	**Chairman (Class Committee)**	**HoD / Civil Engineering**