MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)
END-SEMESTER EXAMINATION, 01/07/22 (02:00-05:00PM)
SUBJECT: Design and Development of Biological Treatment Processes
(BIO 5004)
REVISED CREDIT SYSTEM

ANSWER ALL QUESTIONS

TIME: 3 HOURS **MAX. MARKS: 50**

Q. NO	QUESTION	MARKS	CO	BTL
1A	Present a comparative analysis of the carbon flow during aerobic degradation in an activated sludge system and the carbon flow during anaerobic degradation. You may appropriately assume the partition of carbon towards energy expenditure and biomass production.	3	1	4
1B	Give an account of the enzymes used for the metabolism of celluloses by aerobic and anaerobic microorganisms, with examples for both.	3	1	2
1C	What is the characteristic feature that is similar to oxygen and nitrate respiration? Explain the step-wise sequence in which denitrification proceeds.	4	1	3
2A	What are the different biological processes that happen in an oxidation ditch? What unique features are incorporated in its design to encourage the progress of these processes?	3	2	2
2B	Which single-sludge system comprises of four alternating anoxic and aerobic zones in series? With a labelled schematic, enlist its salient features.	3	2	2
2C	How does the conventional uptake of phosphorus occur in microbes? The stability of a typical EBPR process in waste water treatment plants is always problematic. Reason out why this is so.	4	1	4
3A	I have to estimate the steady state concentration of substrate in the waste water generated from a Completely Mixed Reactor, that is operated without solids recycle stream? What expression do I gave to use, for this?	3	3	2
3B	In the early designs of the plug-flow activated sludge process (ASP), the air application was generally uniform throughout tank length. This was a major design flaw. Identify the problem in this. In variations that were later designed, this was rectified. How was the design changed to circumvent the problem?	3	3	3
3C	The operational expense of a certain design variation of activated sludge process is much costlier than the conventional ASP. It is observed that the efficiency of nitrification is not very good in this model. Identify this model with a labelled sketch. Analyze the reason for the reduced nitrification.	4	2	4
4A	Design a clarifier for a completely mixed reactor that has an influent flow rate of 10275 m^3/day and effluent flow rate of 25 m^3/day. The recycle stream flow rate is 5000 m^3/day.	4	3	4

	<table><tr><th rowspan="2">Tank diameter, m</th><th colspan="2">Side water depth, m</th></tr><tr><th>Minimum</th><th>Recommended</th></tr><tr><td><12</td><td>3.0</td><td>3.4</td></tr><tr><td>12 to 20</td><td>3.4</td><td>3.7</td></tr><tr><td>20 to 30</td><td>3.7</td><td>4.0</td></tr><tr><td>30 to 42</td><td>4.0</td><td>4.3</td></tr><tr><td>>42</td><td>4.3</td><td>4.6</td></tr></table>			
4B	The rate of influent to a CMR removing the BOD content was 10000 m^3/day. The value of soluble BOD_5 in the influent was 84 mg BOD_5/L, which is expected to reduce to a value, 12 times lesser. The CMR is then connected to a CMR designed for nitrification purpose. In this reactor, the influent TKN was measured to be 40 mg/L and the target TKN to be achieved is 1 mg/L. It is estimated that the total amount of sludge that was wasted with respect to both heterotrophs & nitrifiers is 603 kg MLVSS/day. Estimate the volume of air and oxygen to be supplied for achieving the necessary BOD and N removal. It is given that at NTP (T = 20 °C & P = 1 atm), the air density is 1.185 kg/m^3 and the percentage oxygen in air by mass is 23.2%.	**6**	**3**	**4**
5A	25 mL of a waste water sample was collected to determine the biochemical oxygen demand. The variation of the standard method was followed. The water sample was taken in a 250-mL BOD incubation bottle. The initial DO of the diluted sample was 10.2 mg/L, which after 5 days became 2.5 mg/L. The corresponding initial and final DO of the seeded dilution water was 11.5 and 9.3, respectively. Estimate the BOD_5 of the waste water sample?	**3**	**4**	**3**
5B	Treated municipal waste water is put to a lot of applications. Discuss on those two methods which are the highest in terms of reuse volume.	**3**	**4**	**2**
5C	A completely-mixed activated sludge system is to be used for organic matter removal only (one sludge system). The inoculated microorganisms have the following growth constants: • μ_m = 0.104 /hour • K_d = 0.05 /day • Y = 0.5 kg VSS/kg BOD_5 removed • K_S = 0.1 kg BOD_5 / m^3 The influent flow rate is 0.25 m^3/s. The soluble BOD_5 is 95 mg BOD_5/L. If the required effluent has a $(BOD_5)_{total}$ of 30 ppm and suspended solids concentration of 30 ppm, confirm if the safety factor is within the expected range	**4**	**3**	**4**

CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understand, 3-Apply, 4-Analyze, 5-Evaluate, 6-Create