BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

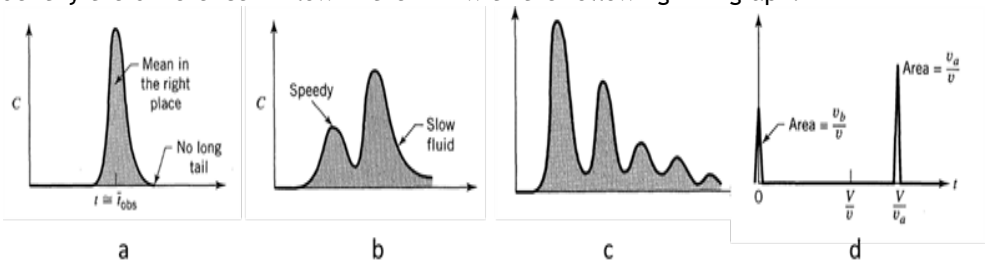
CLASS: B. TECH **SEMESTER : VII**
BRANCH: BIOENGINEERING & BIOTECHNOLOGY **SESSION : MO/2022**

SUBJECT: BE402 BIOREACTOR AND BIOPROCESS DESIGN

TIME: 3:00 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Prove that in a chemostat, at steady state and for sterile feed, μ = D.	[2]	1	3
(b)	Differentiate between Hollow fiber and Packed bed reactor.	[3]	1	2
(c)	Explain the methods to determine volumetric oxygen transfer coefficient in a bioreactor.	[5]	2	3
Q.2(a)	Draw the output C curve for a tracer input (pulse) in a PFR.	[2]	2	2
(b)	Identify the difference in flow in the PFR with the following RTD graph:	[3]	2	4



(c)	A 12-m length of pipe is packed with 1 m of 2-mm material, 9 m of 1-cm material, and 2 m of 4-mm material. Estimate the variance (σ^2) in the output C curve for a pulse input into this packed bed if the fluid takes 2 min to flow through the bed. Assume a constant bed void and a constant intensity of dispersion given by $D/ud_p = 2$.	[5]	2	5
Q.3(a)	Write the scale-up criteria for a bioreactor.	[2]	3	1
(b)	Consider the scale up of fermentation from a 10 L to 10,000 L vessel. The small fermenter has a height to diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500 rpm and three impellers are used. Determine the dimensions of the large fermenter and agitator speed for constant P/V and constant impeller tip speed.	[3]	3	5
(c)	A fungus is cultured in a chemostat (continuous fermentation) at a dilution rate of 0.5 h^{-1}. The feed substrate concentration is 10 g. L^{-1}. Determine the biomass concentration in the chemostat at steady state. Assumptions: Feed is sterile, maximum biomass yield with respect to substrate is 0.4 (g biomass per g ethanol). Microbial growth kinetics is given by MM kinetics, where μ is specific growth rate (h^{-1}), μm = 0.7 h^{-1}, Ks = 0.3 g.L^{-1} and s is substrate concentration (g. L^{-1}).	[5]	4	5
Q.4(a)	Write the difference between a biosensor and an analytical instrument.	[2]	1	2
(b)	Describe the mechanism and application of biosensors.	[3]	4	2
(c)	Explain different physical parameters used to monitor and control fermenter.	[5]	4	3
Q.5(a)	Name the reactor you will prefer when: i) Product inhibits the process; ii) Substrate inhibits the process; iii) Shear stress causing cell damage; iv) Very large surface area is needed?	[2]	1	4
(b)	With the help of flow diagram illustrate the ethanol production process.	[3]	5	3
(c)	It is desired to produce 100 kg fructose per day in a batch reactor by enzymatic reaction. Initial glucose concentration is 100 g/L. Conversion efficiency is 40%. If, K_m = 5×10^{-4} kg/m^3, V_{max} = 1.5×10^{-2} kg/m^3.sec. Down time is 6 h. Calculate the volume of the batch reactor, PFR and MFR.	[5]	5	5

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