Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IISEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, MAY 2017 (REGULAR)

BIO5221- BIOREACTOR DESIGN AND ANALYSIS

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

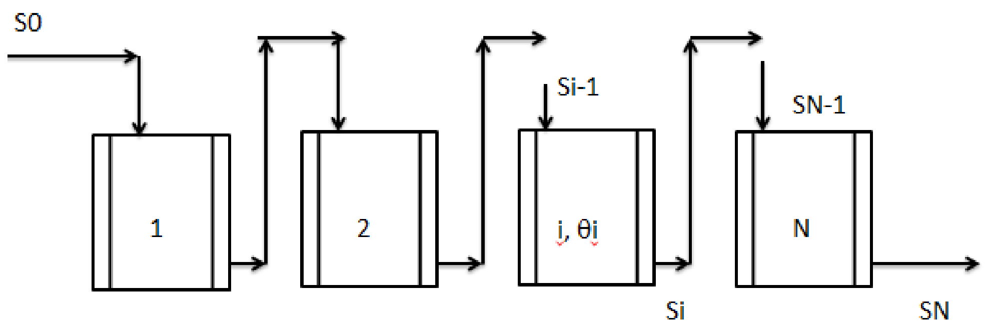
1A.	Explain the various dimensionless parameters used to describe the intra-particle diffusion effects in immobilized enzyme system and explain their physical significance.	**3**
1B.	Hydrolysis of Rice bran oil was carried out in a fixed bed bioreactor using immobilized lipase. The enzyme was immobilized on non-porous glass beads of 2mm diameter. The substrate (S_0=2 M) is pumped from the bottom of the reactor at volumetric flow rate of 8ml/min. Calculate: (i)Interfacial substrate concentration (ii) Damkholar number (iii)Film effectiveness factor Data: V_{max}=0.0281 M/min, K_m=0.231 M, K_{La}=0.09 min^{-1}	**5**
1C	Explain the various techniques that are used to minimize the film resistance in immobilized packed bed bioreactors.	**2**
2A.	What do you mean by constant feed rate policy in the operation of immobilized enzyme reactor system? Develop a suitable model for predicting the time course profiles of conversion due to enzyme deactivation for M-M kinetics, no pore diffusion effects in packed bed bioreactor (PFR).	**5**
2B.	The batch growth data of Bacillus species that is obtained from the shake flask experiments is given in the following table. You are asked to design a two-stage Chemostat reactor system with continuous feed flow rate of 1000 l/h which will produce product P at a concentration of 0.55 g/l. Recommend the best reactor set up which minimizes the total volume. Use the graphical design procedure Data: (see table below)	**5**

Time (h)	0	4	6	8	10	12	14	16
X (g/l)	0.5	1.0	3.0	4.75	7.5	8.0	8.0	8.0
P (g/l)	0	0	0	0.02	0.09	0.2	0.5	0.56

3A.	Consider an enzymatic reaction that is taking place in a cascade reactor system of 'N' Chemostats in series with inlet substrate concentration of S_0. (i)For Michaelis-Menten kinetics derive an expression for the average residence time of the i[th] reactor, τ_i in terms of S_{i-1}, the substrate concentration entering the reactor, S_i the substrate concentration in the i[th] reactor and the enzyme kinetic parameters. (i)Rewrite this equation in	**6**

dimensionless form by introducing following parameters $\alpha = S/S_o$, $k = K_m/S_o$ & $\theta = (\tau_i V_{max})/S_o$

(ii) Find the intermediate α_i values which correspond to the maximum total residence time. Mathematically, these values must satisfy the following equation: $\frac{d[\sum_{i=1}^{N}\theta_i]}{d\alpha_i} = 0$ i = 1, 2,. . . . . , N – 1. Show that this equation reduces to the following simple result: $\alpha_i = \alpha_{i+1}^{i/i+1}$ i = 1, 2,. . . . . , N – 1



<u>CASCADE REACTOR SYSTEM OF 'N' CHEMOSTATS IN SERIES</u>

3B Write on the working of following industrially used bioreactors

I. Bubble column bioreactor
II. Air lift bioreactor

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4A. Lactic acid is produced using Lacto bacillus in a Chemostat under sterile environment with glucose as the substrate, S_0=4 g/l at dilution rate of D=0.3 h^{-1}. Steady state substrate and biomass concentrations are 1.5 and 1.0 g/l respectively. Assume that growth follows the Monod's kinetics with, μ_m=0.53 h^{-1}, Ks=0.12 g/l and Y=0.4

I. Find the controllability matrix for the above system
II. Do you feel that above system is controllable?

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4B. Write the elements of A-matrix during Wash out unstable operation of Chemostat. Find the Eigen values for Biomass and Substrate and based their signs prove that system is unstable.

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5A. The following data were obtained from a non-ideal bioreactor during the RTD experiment using NaCl solution as the tracer material. Calculate

i. Dispersion number (D/UL) and comment on non-ideality
ii. Draw the E (θ) vs θ curve

RTD data:

Time (min)	0	5	10	15	20	25	30	35
Tracer conc. (g/l)	0	3	5	5	4	2	1	0

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5B. Write on the different tracer input signals that are used in RTD experiment. What should be the desirable properties of the tracer material that is used in RTD experiment?

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