Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

V SEMESTER B.TECH. (BIOTECHNOLOGY)
END SEMESTER EXAMINATIONS, NOV/DEC 2016
SUBJECT: BIOPROCESS ENGINEERING [BIO 3102]
REVISED CREDIT SYSTEM
(26/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Discuss the importance of precursors, inhibitors and inducers in the formulation of media with specific examples: **5**

1B. From the following data determine the value of K_M and K_I **5**

S (µmole / ml)	4.7	4.7	4.7	10.8	10.8	10.8	30.3	30.3	30.3
I (µmole / ml)	0	7.58	30.3	0	7.58	30.3	0	7.58	30.3
Rate (µmole / ml min)	0.0434	0.0285	0.0133	0.0713	0.0512	0.0266	0.1111	0.0909	0.0581

2A. The aqueous medium in a fermentor is being sterilized and the time-temp data obtained are as follows: **5**

Time (min)	0	10	20	25	30	35
Temp (°C)	100	110	120	120	110	100

The reaction velocity constant k in min^{-1} for the contaminating bacterial spores can be represented as

$$k = 7.94x10^{38} \exp\left(-68.7x10^{3} / 1.987\,T\right)$$

where T = K. The concentration level $N_0 = 1x10^{12}$ spores. Calculate the sterility level N at the end and del factor.

2B. A continuous culture system is being constructed. The fermentation tank is to be 50, 000 L in size and the residence time to be 2 h. A continuous sterilizer is to be used. The un-sterilized medium contains 10^4 spores/L. the value of k_d has been determined to be 1 min^{-1} at 121°C and 61 min^{-1} at 140°C. For each temperature, determine the required residence time in the holding section so as to ensure 99% of the time four weeks of continuous operation can be obtained without contamination. **5**

3A. Invertase enzyme is immobilized in the form of spherical beads. The reaction follows a first order kinetics with a reaction rate constant of 3.6 h^{-1}. The size of the beads is 12 mm and the effective diffusivity of substrate is 1 x 10^{-6} m^2/sec. **3+2**

a. Does the availability of the substrate limit the reaction? Justify your answer:
b. Now instead of immobilized beads, you are asked to try with rectangular shaped strips of immobilized invertase enzyme. The volume of each strip is 1 x 10^{-9} m^3 and its surface area is 6 x 10^{-6} m^2. Will this new condition affect the availability of the substrate inside the enzyme? Discuss:

3B. An enzyme is immobilized uniformly in a gelatin slab (thickness L and area A). One side is in contact with substrate solution and the other side is in contact with a glass plate. Derive the equation for the substrate concentration with respect to x when the substrate is catalyzed by zero order reaction. Assume that the substrate is transferred by molecular diffusion in the x direction only and the gelatin slab is thick enough to catalyze all the substrate while it diffuses into the slab. What is the critical thickness at which all the substrate is consumed? **5**

4A. The following $C_{O2}(t)$ data were obtained in a 10 L, air sparged laboratory fermenter during the continuous cultivation at 0.5 hr^{-1} of *K. aerogenes* on glucose-based medium, at 37°C. The air was turned off at zero time and the surface of the liquid was swept with a nitrogen gas stream. After 2 minutes, aeration was recommenced. The concentration of *K. aerogenes* remained constant at 5.0 g DCW/L during this period. The solubility of oxygen in water at 37 °C is 7 mg/L for air at atmospheric pressure. Determine the specific oxygen uptake rate of *K. aerogenes* and the mass transfer coefficient under the agitation conditions employed. **2+4**

Time (sec)	0	20	40	60	80	100	120	130	150	170	190	230	250	290	350	400
% Saturation	80	67	54	41	29	16	4.1	24	49	63	71	77	79	80	80	80

4B. A value of k_La = 30 h^{-1} has been determined for a fermentor at its maximum practical agitator rotational speed and with air being sparged at 0.5 vvm. Bacterial cells with an oxygen demand of 10 m mol O_2/g-dry wt –h are to be cultured. The critical dissolved oxygen concentration is 0.2 mg/L. The solubility of oxygen from air in the fermentation broth is 7.3 mg/L at 30°C. **4**

a. What maximum concentration of bacterial cells can be sustained in this fermentor under aerobic concentration?
b. What concentration could be maintained if pure oxygen was used to sparge the reactor?

5A. How do the Logistic equations fit in a better way for the growth of microorganism? Give an example: **5**

5B. From the following data determine in which medium the cells grow at the fastest rate? **5**

Time (days)		0	1	2	4	6	7	8	10
[Cells] (No. of cells/ml)	**Medium A**	3.00 x 10^{-3}	4.92 x 10^{-3}	7.89 x 10^{-3}	2.50 x 10^{-2}	6.40 x 10^{-2}	1.00 x 10^{-1}	9.50 x 10^{-2}	8.40 x 10^{-2}
	Medium B	7.30 x 10^{-3}	1.01 x 10^{-2}	1.38 x 10^{-2}	2.63 x 10^{-2}	4.97 x 10^{-2}	6.85 x 10^{-2}	9.44 x 10^{-2}	8.40 x 10^{-2}