Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – JUNE 2016

SUBJECT: INTRODUCTION TO BIOPROCESS ENGINEERING (BT 122)

(BRANCH: IND. BIOTECH)

FRIDAY, 17th JUNE, 2016

Time: 3 Hours **Max. Marks: 100**

✓ **Answer ANY FIVE FULL Questions.**

1. **(A)** Describe the process of drug development from the point of discovery to its approval process.

(B) What are the rules that govern the proper manufacturing of drugs? Explain, in brief, each such rule. **[10+10]**

2. **(A)** Explain the mechanism of action an enzyme. Compare the progress of a reaction in the presence and absence of an enzyme, with respect to free energy. Add a short note on proximity effect and orientation effect.

(B) What are the approaches devised to derive the velocity of an enzyme-catalyzed reaction? Derive the velocity using rapid equilibrium approach, mentioning clearly the assumptions made. **[10+10]**

3. **(A)** What is competitive inhibition? If a competitive inhibitor is added to an enzyme-catalyzed reaction, how does it influence the maximum reaction velocity and Michaelis constant? Derive the expression for velocity for such an inhibited reaction.

(B) With a labelled schematic of the bubble column reactor, describe its main features. What are its advantages? State an application of this bioreactor. **[10+10]**

4. **(A)** What is feedback inhibition and precursor activation? Explain each with a schematic diagram.

(B) Derive the expression for batch reaction time, under conditions of enzyme deactivation. **[8+12]**

5. **(A)** The equation for aerobic production of acetic acid from ethanol is:

$$C_2H_5OH \text{ (ethanol)} + O_2 \rightarrow CH_3COOH \text{ (acetic acid)} + H_2O$$

Acetobacter aceti bacteria are added to vigorously-aerated medium containing 10 g/L ethanol. After some time, the ethanol concentration is 2 g/L and 7.5 g/L acetic acid is produced. How does the overall yield of acetic acid from ethanol compare with the theoretical yield?

(B) Write short notes on any two methods of determining cell number / density in batch growth of a bacterial specimen. Draw suitable diagrams.

(C) What are the rate expressions for non-growth-associated and mixed-growth associated product formation? State an example for each category. **[4+8+8]**

6. **(A)** What is a biosensor? How can be applied to determine the concentration of a substrate in an enzyme-substrate reaction?

(B) The following data have been obtained for two different initial enzyme concentrations for an enzyme-catalyzed reaction.

V at $[E_0]$ = 0.015 g/L (g/L-min)	**[S] (g/L)**	**V at $[E_0]$ = 0.00875 g/L (g/L-min)**
1.14	20.0	0.67
0.87	10.0	0.51
0.70	6.7	0.41
0.59	5.0	0.34
0.50	4.0	0.29
0.44	3.3	
0.39	2.9	
0.35	2.5	

i. Find K_m

ii. Find V_m for $[E_0]$ = 0.015 g/L

iii. Find V_m for $[E_0]$ = 0.00875 g/L

iv. Find k_2 for both values of $[E_0]$. **[4+16]**

7. **(A)** State any three applications of enzymes used for medical diagnosis and/or therapeutical purposes.

(B) To measure the amount of glucoamylase in a crude enzyme preparation, 10 mL of the crude enzyme preparation containing 8 mg protein is added to 9 mL of 4.44% starch solution. One unit of activity of glucoamylase is defined as the amount of enzyme which produces 1 µmol of glucose per min in a 4% solution of Lintner starch at pH 4.5 and 60ºC. Initial rate experiments show that the reaction produces 0.6 µmol of glucose per mL per min. What is the specific activity of the crude enzyme preparation? If V_m = 1 µmol per mL per min, find k_2.

(C) What do you understand by a Minimal medium? Define macronutrients and micronutrients with examples of both. **[6+6+8]**

8. **(A)** State three advantages & three disadvantages of immobilization of enzymes.

(B) Show graphically, the variation of biomass concentration and product concentration with time in (i) growth-associated product formation (ii) mixed-growth-associated product formation (iii) non-growth-associated product formation.

(C) In a competitive inhibition experiment, a structural analog was used along with the substrate and the following kinetics was observed: At 10µM substrate, the velocity was 25 µM/min. With 2mM of the analog, the velocity dropped to 50%. Calculate the K_i of the inhibitor. Given that the substrate concentration used gives half-maximal velocity, calculate how much inhibitor should be used for increasing the K_m to 10 times the uninhibited value? **[6+6+8]**