BIOPROCESS & PROCESS INSTRUMENTATION
(BIOT 3133)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Higher value of Michaelis constant signifies
(a) increased substrate affinity of the enzyme
(b) reduced substrate affinity of the enzyme
(c) decreased enzyme reaction rate
(d) none of the above.

(ii) What is the recommended unit of enzyme activity?
(a) Katal (b) Mm (c) mM/h (d) All of the above

(iii) Which of the following time is very minimal in continuous sterilization?
(a) Heating time (b) Cooling time
(c) Holding time (d) Both (a) and (b).

(iv) The destruction of microorganisms by moist heat is described by _____.
(a) Zero-order reaction (b) First-order reaction
(c) Third-order reaction (d) Second-order reaction

(v) Bacterial growth curve is obtained by plotting
(a) number of cells versus time (b) number of spores versus time
(c) log of number of cells versus time (d) number of cells survived versus time.

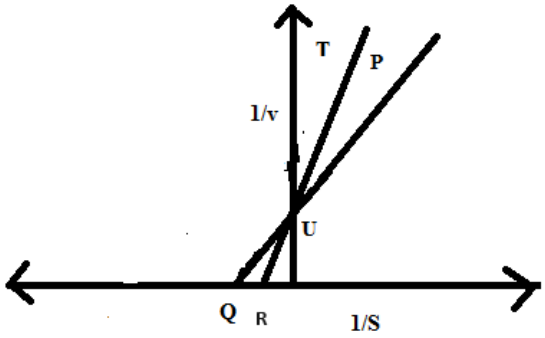
(vi) Wash out in steady state fermentation occurs when
(a) dilution rate is less than maximum specific growth rate
(b) dilution rate is higher than the maximum specific growth rate
(c) cell concentration reaches the maximum
(d) specific growth rate is maximum.

(vii) T type thermocouple is made of
(a) iron-constantan (b) copper -constantan
(c) platinum-rhodium (d) chromel-alumel.

(viii) U tube manometer is used to measure the pressure of
(a) Liquid (b) gas (c) liquid and gas (d) solid

(ix) Which of the following is true for bimetallic type thermometer?
(a) Two metals have same temperature coefficients
(b) Two metals have different temperature coefficient
(c) One metal is cooled always
(d) None of the mentioned.

(x) Identify the type of enzyme inhibition shown in the graph



(a) Uncompetitive inhibition (b) Competitive inhibition
(c) Non-competitive inhibition (d) substrate inhibition

Fill in the blanks with the correct word

(xi) _____ heat is used in autoclave.

(xii) The formula to calculate pH of a solution is _____.

(xiii) The phenomenon in which substrates are used in a sequential manner is known as _____.

(xiv) When binding of one substrate to the enzyme facilitates binding of other substrate molecules, the phenomenon is known as _____.

(xv) The growth of cells become oxygen limited when the dissolved oxygen concentration becomes _____.

Group - B

2. (a) What is enzyme inhibition? What are the different types of enzyme inhibitions are there? *[(CO1)(Analyse/HOCQ)]*

(b) Derive an equation for rate of product formation in an enzyme reaction with competitive inhibition. *[(CO1)(Remember/LOCQ)]*

(2 + 2) + 8 = 12

3. (a) Enzyme E catalyzes the transformation of reactant A to product R as follows A+ E→R+E, $-r_A = (200C_AC_{E0})/(2 + C_A)$, mol/L.min). If we introduce enzyme (C_{E0}= 0.001mol/L) and reactant (C_{A0}= 10mol/L) into a batch reactor and let the reaction proceed, find the time needed for the concentration of reactant to drop to 0.025mol/L. Note that the concentration of the enzyme remains unchanged during the reaction. *[(CO2)(Analyse/HOCQ)]*

(b) Find a rate equation to represent the breakdown of cellulose by cellulase in the absence of inhibitor. *[(CO1)(Remember/LOCQ)]*

6 + 6 = 12

Group - C

4. (a) Derive the equation for cell death kinetics during sterilisation of media. *[(CO3)(Remember/LOCQ)]*

(b) Show the plot between $\ln(N_t/N_o)$ vs time for sterilisation of media containing a mixed culture with high concentration of heat resistant organism and low concentration of heat sensitive organism. *[(CO3)(Analyse/IOCQ)]*

6 + 6 = 12

5. Medium at a flow rate of 2 m^3 hr^{-1} is to be sterilised by heat exchange with steam in a continuous steriliser. The liquid contains bacterial spores at a concentration of 5 × 1012 m^{-3}. The activation energy and Arrhenious constant for thermal destruction of these contaminants 283KJ $gmol^{-1}$ and 5.7 × 10^{39} hr^{-1}, respectively. A contamination risk of one organism surviving every 60 days' operation is considered acceptable. The steriliser pipe has an inner diameter of 0.1 m, the length of holding section is 24 m. The density of medium is 1000 kgm^{-3} and viscosity is 3.6 kgm^1hr^{-1}. What sterilization temperature is required if Damkohler number (Da) corresponding to this system is taken as 42? Also find out Reynold's number. *[(CO4)(Evaluate/HOCQ)]*

(9 + 3) = 12

Group - D

6. The following data are obtained in a chemostat for the growth of *E. aerogenes* on a glycerol-limited growth medium (S_0 = 10mg/ml). For this system estimate the values of: (i) K_s, mg glygerol/mL, (ii) μ_m. h^{-1}, (iii) $Y_{x/s}$, mg cells /mg glycerol and (iv) m_s, mg glycerol/mg cells.h.

$D(h^{-1})$	0.05	0.1	0.2	0.4	0.6	0.7	0.8	0.84
S(mg/ml)	0.012	0.028	0.05	0.1	0.15	0.176	0.8	9
X(mg/ml)	3.2	3.7	4	4.4	4.75	4.9	4.5	0.5

[(CO3)(Analyse/HOCQ)]

(4 + 3 + 3 + 2) = 12

7. *Pseudomonas sp* has a mass doubling time of 2.4h when grown on acetate. The saturation constant using this substrate is 1.3g/L and cell yield on acetate is 0.46gcell/g acetate. If we operate a chemostat on a feed stream containing 38g/L acetate, find the following:

(i) Cell concentration when the dilution rate is one-half of the maximum

(ii) Substrate concentration when the dilution rate is $0.8D_{max}$

(iii) Maximum dilution rate

(iv) Cell productivity at $0.8D_{max}$. *[(CO5)(Calculate/IOCQ)]*

(3 + 3 + 3 + 3) = 12

Group - E

8. (a) Explain the following:
(i) Seebeck effect
(ii) Peltier effect. *[(CO6)(Analyse/IOCQ)]*

(b) Illustrate on any method of dissolved oxygen measurement. *[(CO6)(Illustrate/IOCQ)]*

6 + 6 = 12

9. (a) Describe the working principle of Orificemeter for flow rate measurement. *[(CO5)(Analyse/HOCQ)]*

(b) Describe the principle of thermocouple. *[(CO6)(Remember/LOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	21	37.5	41.5