

**BIOPROCESS & PROCESS INSTRUMENTATION
(BIOT 3133)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) 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.
- (ii) 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.
- (iii) 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) log of number of cells survived versus time.
- (iv) The phenomenon in which substrates are used in a sequential manner is known as
(a) trans-substrate genesis
(b) dialism
(c) diauxic
(d) multiplicity.
- (v) The dilution rate, D is defined as (where, F = volumetric flow rate, V_R = total volume of culture in the reactor and μ specific growth rate)
(a) F/V_R (b) V_R/F (c) μ/F (d) F/μ .
- (vi) Continuous sterilization is better over Batch sterilization due to
(a) Protection of nutrient value
(b) Easier automatic control
(c) Decrease in sterilization time
(d) All of the above.
- (vii) 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

(viii) Thermocouple works on

- (a) Seebeck effect (b) Peltier effect
(c) Thomson effect (d) Kelvin effect.

(ix) Bourdon tubes are _____.

- (a) very highly sensitive to shock (b) not sensitive to shock
(c) less sensitive to shock (d) more sensitive to shock

(x) U tube manometer is used to measure the pressure of

- (a) Liquid (b) gas (c) liquid and gas (d) solid.

Group - B

2. An inhibitor I is added to the enzymatic reaction at a level of 1.0g/l. The following data were obtained for $K_m = 9.2\text{g/l}$. Identify the type of inhibition and find K_i .

v, g/(L.min)	0.909	0.658	0.493	0.4	0.333	0.289	0.227
S, g/L	20	10	6.67	5	4	3.33	2.5

[(CO2)(Examine/IOCQ)]

12

3. At room temperature sucrose is hydrolyzed by the enzyme sucrose as follows:

Sucrose + sucrose \rightarrow products + sucrose.

Starting with sucrose ($S_0 = 1\text{mol/m}^3$) and sucrose ($E_0 = 0.01\text{mol/m}^3$) the following data are obtained in a batch reactor.

S, mol/m ³	0.68	0.16	0.006
t, h	2	6	10

Find the kinetic constants involved in the enzyme reaction.

[(CO2)(Examine/HOCQ)]

12

Group - C

4. Medium at a flow rate of $2\text{ m}^3\text{ hr}^{-1}$ is to be sterilised by heat exchange with steam in a continuous steriliser. The liquid contains bacterial spores at a concentration of $5 \times 10^{12}\text{ m}^{-3}$. The activation energy and Arrhenius constant for thermal destruction of these contaminants 283KJ gmol^{-1} and $5.7 \times 10^{39}\text{ hr}^{-1}$, 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 $3.6\text{ kgm}^{-1}\text{hr}^{-1}$. What sterilization temperature is required if Damkohler number (Da) corresponding to this system is taken as 42? Also find out Reynold's number.

[(CO3) (Evaluate/HOCQ)]

(9 + 3) = 12

5. What is Del Factor in connection with sterilisation of biological media? Derive the design equation of batch sterilisation relating number of organism viable at each stage of batch sterilisation with Overall Del Factor of the sterilisation process. [(CO3) (Derive/IOCQ)]

12

Group – D

6. *E.coli* is cultivated in continuous culture under aerobic conditions with a glucose limitation. When the system is operated at $D=0.2\text{h}^{-1}$, determine the effluent glucose and biomass concentrations by using the following equations ($S_0=5\text{g/L}$, $Y_{x/s}=0.4\text{gX/gS}$):
- (i) Monod equation: $\mu_m=0.25\text{h}^{-1}$, $K_s=100\text{mg/L}$
- (ii) Tessier equation: $\mu_m=0.25\text{h}^{-1}$, $K=0.005\text{(mg/L)}^{-1}$. [[CO4](Evaluate/HOCQ)]
- 12**
7. *Pseudomonas sp* has a mass doubling time of 2.4 h when grown on acetate. The saturation constant using this substrate is 1.3 g/L and cell yield on acetate is 0.46 gcell/g acetate. If we operate a chemostat on a feed stream containing 38 g/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 $0.8D_{\text{max}}$
- (iii) Maximum dilution rate
- (iv) Cell productivity at $0.8D_{\text{max}}$. [[CO5](Calculate/IOCQ)]
- 12**

Group – E

8. (a) Explain the working principle of thermocouple. [[CO6](Explain/LOCQ)]
- (b) How does resistance temperature detector works? [[CO6](Understand/LOCQ)]
- 6 + 6 = 12**
9. (a) How does the diaphragm type pressure transducer work? [[CO6](Explain/IOCQ)]
- (b) Illustrate on any method of dissolved oxygen measurement. [[CO6](Illustrate/IOCQ)]
- 6 + 6 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	12.5	50	37.5

Course Outcome (CO):

After the completion of the course students will be able to:

- Understand the mechanism of enzyme action on a substrate explicitly.
- Apply the above concepts to solve problems in the enzyme technology field.
- Comprehend and solve any problem regarding sterilization of the medium used in fermentation.
- Compare between a batch process and a continuous process regarding microbial growth.
- Classify a microbial product and determine its productivity.
- Appreciate the operation of different process instruments used for measuring various operating parameters of a bioprocess.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.

