

**BIOPROCESS TECHNOLOGY  
(BIOT 5241)**

**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) Which among the following is an assumption of Hagen-Poiseuille equation?  
(a) number of organism  
(b) kind of organism  
(c) type of media  
(d) all the above
- (ii) In sterilization process, spore of which of the following organism is considered as control?  
(a) *Bacillus subtilis*  
(b) *Clostridium botulinum*  
(c) *Bacillus stearothermophilus*  
(d) *Aspergillus niger*
- (iii) Full form of HTST sterilization is  
(a) High temperature short time  
(b) Hot thermal sterilization technique  
(c) High time short temperature  
(d) None of these
- (iv) The relationship between the del factor, temperature and time is given as  
(a)  $\Delta = A.t. e^{-E/RT}$   
(b)  $\Delta = 1/(A.t. e^{-E/RT})$   
(c)  $\Delta = A.t. e^{E/RT}$   
(d)  $\Delta = A.t.T$
- (v) Which of the following reaction contribute in the decrease of nutrient value during sterilization?  
(a) Brownian movement  
(b) Dehydrogenation  
(c) Dehydration  
(d) Millard type Browning Reaction.

- (vi) Molasses and corn steep liquor are usually used as  
 (a) Carbon source for large scale industrial fermentation process  
 (b) Carbon source for small scale industrial fermentation process  
 (c) Mineral source for large scale industrial fermentation process  
 (d) Mineral source for small scale industrial fermentation process
- (vii) When binding of one substrate to the enzyme facilitates binding of other substrate molecules, the phenomenon is known as  
 (a) Allostery  
 (b) Inhibition  
 (c) Immobilization  
 (d) Induced fit
- (viii) The dissolved oxygen concentration in the medium below which the microbial system becomes oxygen limited is called  
 (a) Saturation level  
 (b) Critical level  
 (c) Optimum level  
 (d) None of the above
- (ix) Amount of CO<sub>2</sub> produced per amount of O<sub>2</sub> consumed is known as  
 (a) Yield coefficient  
 (b) Respiratory quotient  
 (c) Degree of reduction  
 (d) Maintenance coefficient
- (x) 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

*Fill in the blanks with the correct word*

- (xi) RNA molecules that have catalytic properties are called\_\_\_\_\_.
- (xii) An enzyme containing a non-protein group is called \_\_\_\_\_.
- (xiii) The microbial death kinetics is \_\_\_\_\_ order reaction.
- (xiv) Dilution rate (D) is equal to \_\_\_\_\_.
- (xv) Full form of pressure unit psi is \_\_\_\_\_.

### **Group - B**

2. Derive Michaelis-Menten equation by both the approaches. What is the physical significance of K<sub>M</sub>?

*[(CO3)(Evaluate/HOCQ)]*

**(5 + 5 + 2) = 12**

3. (a) Decarboxylation of glyoxalate(S) by mitochondria is inhibited by malonate(I). Using the following data obtained in batch experiments, determine the following:

S, mM		0.25	0.33	0.4	0.5	0.6	0.75	1.00
V, mM/h	I=0	1.02	1.39	1.67	1.89	2.08	2.44	2.5
V, mM/h	I=1.26mM	0.73	0.87	1.09	1.3	1.41	1.82	2.17
V, mM/h	I=1.95mM	0.56	0.75	0.85	1	1.28	1.39	1.82

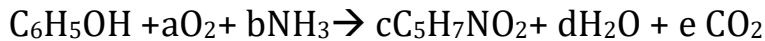
- i) What type of inhibition is this?  
 ii) Determine the constants  $V_{max}$ ,  $K_m'$  and  $K_i$ .

[[CO1](Analyse/IOCQ)]

12

### Group - C

4. Aerobic degradation of phenol by a mixed culture of organisms in industrial effluent can be represented by the following reaction.



- i. Determine a,b,c,d, and e if RQ= 0.8.  
 ii. Determine the yield coefficients  $Y_{x/O_2}$  and  $Y_{x/s}$ .  
 iii. Determine the degree of reduction for the substrate and bacteria.

[[CO2](Apply/IOCQ)]

12

5. (a) The following data are obtained in a chemostat for the growth of *E. aerogenes* on a glycerol-limited growth medium ( $S_0 = 10\text{mg/ml}$ ).

D(h <sup>-1</sup> )	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

For this system estimate the values of :i)  $K_s$ , mg glycerol/mL, ii)  $\mu_m$ , h<sup>-1</sup>, iii)  $Y_{x/s}$ , mg cells /mg glycerol and iv)  $m_s$ , mg glycerol/mg cells.h.

[[CO3](Analyse/HOCQ)]

12

### Group - D

6. Medium at a flow rate of 2 m<sup>3</sup> hr<sup>-1</sup> is to be sterilised by heat exchange with steam in a continuous steriliser. The liquid contains bacterial spores at a concentration of  $5 \times 10^{12}$  per m<sup>3</sup>. The activation energy and Arrhenius constant for thermal destruction of these contaminants 283 KJ gmol<sup>-1</sup> and  $5.7 \times 10^{39}$  hr<sup>-1</sup>, respectively. A contamination risk of one organism surviving in 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<sup>-3</sup> and viscosity is 3.6 kgm<sup>-1</sup>hr<sup>-1</sup>. What sterilization temperature is required if Damkohler number (Da) corresponding to this system is 42?

[[CO4](Calculate/HOCQ)]

12

7. (a) State four criteria for formulation of fermentation media. [[CO3](remember/LOCQ)]

- (b) Differentiate between Defined media and Technical media for microbial growth with examples. [[CO3](Remember/LOCQ)]
- (c) Describe the methods used for in-situ sterilization of fermenter in industrial scale. [[CO5](Understand/IOCQ)]
- 5 + 4 + 3 = 12**

### Group - E

8. (a) Describe the relative advantages and disadvantages of choosing the following organisms as host cell for production of protein with genetically engineered cells: (i) *E.coli* (ii) Lower eukaryotic cells.
- (b) What is the difference between protein secretion and protein excretion? [[CO6](analyse/IOCQ)]
- (c) Name two proteins which *E. coli* excretes extracellularly. [[CO6](remember/LOCQ)]
- 8 + 2 + 2 = 12**
9. (a) List the factors those affect alcohol fermentation process. [[CO6](remember/IOCQ)]
- (b) Explain the purification steps included in recovery of penicillin from fermentation broth. [[CO6](Analyse/IOCQ)]
- 6 + 6 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	11.5	51	37.5

#### Course Outcome (CO):

After completion of the course the students will be able to

1. Describe the mechanism of all types of enzyme substrate reactions,
2. Calculate various kinetic parameters associated therewith,
3. Comprehend various factors affecting the growth of cells and formation of products,
4. Solve mathematical problems related to various bioprocesses
5. Design mathematically model upstream and fermentation processes, and
6. Apply the concepts in real time industrial scenarios in biotechnology.

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