BIOPROCESS & PROCESS INSTRUMENTATION
(BTC3133)

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.

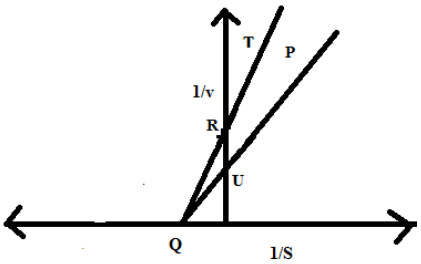
Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Identify Q, R, U, P and T respectively from the graph below.



(a) $-1/K_m$, $-1/V_{m,app}$, $1/V_{max}$, [I]=0, [I]>0
(b) $-1/K_{m,app}$, $-1/K_m$, $1/V_{max}$, [I]=0, [I]>0
(c) $-1/K_{m,app}$, $-1/K_m$, $1/V_{max}$, [I]>0, [I]=0
(d) $1/V_{max}$, $1/V_{max,app}$, $-1/K_m$, [I]=0, [I]>0

(ii) Lower 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) Which of the following is the method of filter sterilization?
(a) Osmosis (b) Diffusion
(c) Internal impaction (d) both (a) and (b)

(iv) Batch sterilization cycle time consist of
(a) Three phase (b) Four phase
(c) Two phase (d) Five phase

(v) Which type of medium contains only known and defined compounds?
(a) Complex medium (b) Natural medium
(c) Synthetic or Defined medium (d) Semi-synthetic medium

(vi) In a turbidostat
(a) cell concentration in the culture is maintained constant by monitoring optical density of the culture
(b) feed flow rate is controlled
(c) environment is dynamic
(d) all the above

(vii) When a bacterial culture is grown in presence of two carbon sources the growth is known as
(a) Diauxic growth (b) Cryptic growth
(c) Endogenous metabolism (d) None of the above

(viii) RTD stands for
(a) Resistance temperature deflector (b) Resistance transfer deflector
(c) Resistance temperature detector (d) Resistance transfer detector

(ix) The temperature of steam at around 540^{o}C can be measured by
(a) Thermometer (b) Radiation pyrometer
(c) Thermopile (d) Thermocouple

(x) Absolute pressure is
(a) Gauge pressure plus atmospheric pressure
(b) Gauge pressure less atmospheric pressure
(c) Gauge pressure plus atmospheric pressure divided by 2
(d) Atmospheric pressure less gauge pressure

Fill in the blanks with the correct word

(xi) Negative temperature coefficient is the property of _____ type of temperature measuring devices.

(xii) Optimum holding time for sterilisation is _____ minutes.

(xiii) Rate of a reaction is a function of _____.

(xiv) Enzymes may hold the substrates at certain positions and angles to improve the reaction rate, it is called_____.

(xv) _____ at steady state (in terms of oxygen supply to the medium)

Group - B

2. (a) Derive a batch kinetic mathematical model for enzyme substrate reaction.
[(CO1)(Remember/LOCQ)]

(b) Compare different types of enzyme inhibition graphically while explaining the differences explicitly. *[(CO2)(Apply/IOCQ)]*

8 + 4 = 12

3. In cultivation of baker's yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately.Increase in dissolved oxygen (DO) concentration upon addition of lethal agents is followed with the aid of a DO

analyzer and a recorder. Using thefollowing data, determine the oxygen transfer coefficient (k_la) for the reactor. Saturation DO concentration is C* = 9mg/L.

Time(min)	1	2	2.5	3	4	5
DO(mg/L)	1	3	4	5	6.5	7.2

[(CO4)(Analyse/HOCQ)]

12

Group - C

4. (a) Mathematically prove that as time approaches to infinity, the number of viable organism approaches to zero in a liquid media during heat sterilisation. *[(CO4)(Analyse/IOCQ)]*

   (b) Compare between the batch sterilization and continuous sterilization with respect to their relative advantages and disadvantages *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

5. A medium containing vitamin is to be sterilised . Assume that the number of spores initially present is 10^5/lit. The values of Arrhenius constant and activation energy for the spores are E=65Kcal/gmol, A=$1x10^{36}min^{-1}$. For the inactivation of vitamin E=10Kcal/gmol, A=$1x\ 10^4\ min^{-1}$. The initial concentration of vitamin is 30 mg/lit. What is the amount of active vitamin in sterile medium of 10 lit when sterilised to 121°C, if probability of unsuccessful sterilization is 0.001. Ignore the effect of heat-up and cool down periods. *[(CO3)(Apply/HOCQ)]*

12

Group - D

6. (a) Write a detail essay on the different microbial growth phases in the growth curve *[(CO4)(Remember/LOCQ)]*

   (b) What are the different factors that affect the lag phase of microbial growth? *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

7. *E. coli* is cultivated in continuous culture under aerobic conditions with a glucose limitation. When the system is operated at D=$0.2h^{-1}$, determine the effluent glucose and biomass concentrations by using the following equations(S_0=5g/L, $Y_{x/s}$=0.4gX/gS):
   (i) Monod equation: μ_m= $0.25h^{-1}$, K_s= 100mg/L
   (ii) Tessier equation: μ_m= $0.25h^{-1}$, K= $0.005(mg/L)^{-1}$ *[(CO5)(Calculate/IOCQ)]*

6 + 6 = 12

Group - E

8. (a) How does the diaphragm type pressure transducer work? *[(CO6)(Describe/IOCQ)]*

   (b) Explain the working principle of thermocouple. *[(CO6)(Understand/IOCQ)]*

6 + 6 = 12

9. (a) Describe the working principle of Thermister. *[(CO6)(Understand/HOCQ)]*

(b) Why is bellow resistance transducer used and how does it work.

[(CO6)(Remember/LOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.3	35.4	31.3