GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022
Principles of Biochemical Engineering
FT802A

TIME ALLOTTED: 3 HOURS **FULL MARKS: 70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

			Marks	CO No
1.	(i)	The volume of liquid (V_L) in a cylindrical reactor can be calculated from the liquid height (H_L) and tank diameter (D_t) using the following equation a) $V_L = 4/3 \times \pi \times H_L \times D_t^3/8$ b) $V_L = H_L \times \pi \times D_t^2/4$ c) $V_L = H_L \times \pi \times D_t^2$ d) $V_L = 4 \times \pi \times D_t^2$	1	CO5
	(ii)	For purification of extra cellular enzyme the step should be omitted is a) Fermentation b) Cell disruption c) Protein precipitation d) Enzyme purification	1	CO4
	(iii)	The value for flow behavior index for Newtonian fluid: a) 0 b) ½ c) 1 d) 3/2	1	CO5
	(iv)	Ethanol fermentation is carried out with the organism: a) E. coli b) S. cereviseae c) B. subtilis d) X. campestris	1	CO1
	(v)	During centrifugation the forces acted on a solid particle a) Gravitational force and drag force b) Drag force and buoyant force c) Buoyant force and gravitational force d) Gravitational force, buoyant force and drag force	1	CO3
	(vi)	Why vortexing is undesirable in the agitation of biological systems? a) Poor mixing despite the use of high stirrer speeds b) The collision between the cells, impeller and air bubbles will lead to cell damage c) Mixing will not be in the turbulent region d) All of the above	1	CO3

(vii)	The peaks overlap when the resolution parameter (R) is a) Less than 1 b) Equals to 1 c) Greater than 1 d) None of these	1	CO5
(viii)	RQ means a) Respiratory Quotient b) Retention Quotient c) Moles of CO_2/O_2 consumed d) Both a & c	1	CO2
(ix)	Bubble columns are industrially applied for production of a) Baker's yeast b) Beer c) Vinegar d) All of them	1	CO3
(x)	Which of the following reactors are mainly used with immobilized cells? a) Packed bed b) Bubble column c) Trickle bed d) None of these	1	CO3
(xi)	_____ are produced by A. Niger a) Pectinases b) Hemicellulases c) Amylases d) All of these	1	CO1
(xii)	Selectivity can be expressed as a) ratio of the distribution coefficients in different solute b) mass fraction of the solute in the extract phase at equilibrium c) mass fraction of the solute in the raffinate phase d) ratio of the mass fraction of the solute in the extract phase to the raffinate phase	1	CO5
(xiii)	Which of the following is not the physical method for the cells rupturing? a) Milling b) Homogenization c) Ultrasonication d) Enzymatic digestion	1	CO5

GROUP – B
(Short Answer Type Questions)
Answer any ***three*** from the following: **3×5=15**

		Marks	CO No
2.	Write the major steps involved in the separation and purification of intracellular enzymes.	5	CO4
3.	Derive the equation of relative velocity (U_o) for centrifugation method.	5	CO3

4. Egg white proteins are being separated by isocratic chromatography using 10 cm long column. The distribution co-efficient for the proteins are given below: — 5 — CO4

Protein	Distribution Co-efficient
Ovalbumin	0
Conalbumin	1
Lysozyme	5

If the voidage fraction of the column is 0.45 and the mobile phase retention time is 10 mins. Predict the retention time of the three proteins. Comment on the selectivity and resolution of separation. (N= 250)

5 (a) The equation for aerobic production of acetic acid from ethanol is: — 4 — CO2

$$C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$$

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

(b) Define RQ — 1 — CO2

6. With diagram, explain the packed bed reactor with recycle — 5 — CO1

GROUP – C
(Long Answer Type Questions)
Answer any ***three*** from the following: **3×15=45**

Marks **CO No**

7. (a) A 30 ml sample of broth from a penicillin fermentation is filtered in the laboratory on a 3 cm^2 filter at a pressure drop of 5 psi. The filtration time is 4.5 min. Previous studies have shown that filter cake of *Penicillium chrysogenum* is significantly compressible with s = 0.5. If 500 litres broth from a pilot scale fermenter must be filtered in 1hour, what size filter is required if the pressure drop is — 8 — CO3

i) 10 psi ii) 5 psi
Resistance due to the filter medium is negligible

(b) Describe the process of rotary vacuum filtration — 7 — CO4

8. Describe different methods of cell disruption. — 15 — CO4

9. The following data were obtained in a constant-pressure filtration of a yeast suspension. — 15 — CO3

t(min)	4	20	48	76	120
V (l filtrate)	115	365	680	850	1130

Characteristics of the filter are as follows:

$A = 0.28m^2$, $C=1920kg/m^3$, $\mu = 2.9x10\text{-}3$ kg/m-s, $\alpha = 4m/kg$

i. determine the pressure drop across the filter

ii. determine the filter medium resistance (r_m)

determine the size of filter for the same pressure drop to process 4000 l of cell suspension in 20 min.

10		Give Short Notes on *any three* of the following:	3x5=15	
	(a)	Vitamin production	5	CO1
	(b)	Penicillin production	5	CO1
	(c)	Ethanol production	5	CO2
	(d)	Citric acid Production	5	CO3
	(e)	Lactic acid production	5	CO2
11	(a)	Discuss the difference between Chemostat and Turbidostat.	5	CO3
	(b)	In a chemostat with recycle, the feed flow rate and culture volumes are F = 100ml/h and V= 1000 ml, respectively. The system is operated under glucose limitation, and the yield coefficient, $Y^M_{X/S} = 0.5$ gdw cells/g substrate. Glucose concentration in the feed is So = 10 g glucose/l. The kinetic constants of the organisms are $\mu m = 0.2\ h^{-1}$, K_s = 1g glucose/l. The value of C is 1.5, and the recycle ratio is $\alpha = 0.7$. The system is at steady state. a. Find the substrate concentration in the recycle stream (S) b. Find the specific growth rate (μ_{net}) of the organisms. c. Find the cell (X_1 biomass) concentration in the recycle stream. d. Find the cell concentration in the centrifuge effluent (X_2)	10	CO3
12.	(a)	Discuss the chromatography system	7	CO3
	(b)	A plasmid was found to have a retention time of 10minutes in a chromatographic column having a volume of 0.001 m^3 and a voidage fraction of 0.3. The distribution coefficient (K) of the plasmid is known to be equal to 2. Calculate the mobile phase retention time and flow rate at which the above separation was carried out. If the use of the same column-mobile phase system is to be used to separate the plasmid from RNA (which has a capacity factor of 4.66). Comment on the feasibility	8	CO3