GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2021
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.	Penicillin is active against gram positive bacteria. a) True b) False	1	CO1
	iii.	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
	iv.	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
	v.	Vinegar contains a) 10% acetic acid b) 4% acetic acid c) 10% alcohol d) 4% alcohol	1	CO1

vi.	Why vortexing is undesirable in the agitation of biological systems? a) The collision between the cells, impeller and air bubbles will lead to cell damage b) Poor mixing despite the use of high stirrer speeds c) Mixing will not be in the turbulent region d) All of the above	1	CO3
vii.	Y_{CS} stands for: a) Mass or moles of carbon dioxide formed per unit mass or moles of substrate consumed b) Moles of carbon dioxide formed per mole of oxygen consumed c) Mass or moles of biomass formed per calorie of heat evolved during fermentation d) None of these	1	CO2
viii.	Raffinate in extraction process is a) the spent feed after extract has been taken out of it b) the extracting solvent c) the feed which enters the extractor d) none of these	1	CO4
ix.	The oxygen transfer rate in a bioreactor will increase if a) Oil is added b) antifoam is added c) detergent like molecules are added d) increase in the reactor temperature	1	CO3
x.	Bubble columns are industrially applied for production of a) Baker's yeast b) Beer c) Vinegar d) All of them	1	CO3
xi.	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
xii.	The scale-up criterion (Maximum Impellar Speed or Mamx. Shearing Rate) is designated by a) P_o/V b) Q/V c) $N.D_i$ d) Q	1	CO5

GROUP – B
(Short Answer Type Questions)

Answer any ***three*** from the following: **3×5=15**

			Marks	CO No
2.		With diagram, explain the packed bed reactor with recycle.	5	CO4
3.	a)	Write the major steps involved in the separation and purification of intracellular enzymes.	3	CO4
	b)	What are the strategies to recover and purify products?	2	CO3
4.		Describe ultracentifugation.	5	CO5
5.		Consider the scale up of a fermentation process from 10l to 10,000l vessel. The small fermenter has a height to diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500 rpm and 3 impeller are used. Determine the dimensions of the larger fermenter and agitator speed for (i) constant P/V (ii) constant impeller tip speed (iii) constant Reynolds no. Assume vessels are cylindrical and geometrically similar.	5	CO4
6.	a)	The equation for aerobic production of acetic acid from ethanol is: $C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$ *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?	4	CO1
	b)	Define RQ	1	CO2

GROUP – C
(Long Answer Type Questions)

Answer any ***three*** from the following: **3×15=45**

			Marks	CO No
7.	a)	Discuss the Chemostat with different conditions (cell concentration and substrate concentration)	7	CO4
	b)	chemostat with cell recycle , the feed flow rate and culture volumes are F= 100ml/h and V=1000ml,respectively. The system is operated under glucose limitation, and the yield coefficient, $Y^{M}_{X/S}$, is 0.5 gdw cells/g substrate. Glucose concentration in the feed is S_o = 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 α =0.7. The system is at steady state.	8	CO4

i. Find the substrate concentration in the recycle stream (S).
ii. Find the specific growth rate (μ_{net}) of the organisms.
iii. Find the cell (biomass) concentration in the recycle stream.
iv. Find the cell concentration in the centrifuge effluent (X_2)

8. Give Short Notes on *any three* of the following: 15 CO1
   i. Single cell protein
   ii. Vinegar Production
   iii. Lactic acid production
   iv. Penicillin production
   v. Vitamin production

9. a) Egg white proteins are being separated by isocratic chromatography using 10 cm long column. The distribution co-efficient for the proteins are given below: 8 CO3

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.

b) Discuss about the chromatography system 7 CO3

10. Describe different methods of cell disruption. 15 CO5

11. a) Describe the process of rotary vacuum filtration 5 CO5

b) The following data were obtained in a constant-pressure filtration of a yeast suspension. 10 CO5

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, μ = 2.9x10-3 kg/m-s, α = 4m/kg

i. determine the pressure drop across the filter
ii. determine the filter medium resistance (rm)
iii. determine the size of filter for the same pressure drop to process 4000 l of cell suspension in 20 min.