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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN  
 [AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]  
 Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

**Question Paper Code: 90001**

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – NOV. / DEC. 2025

Seventh Semester

Biotechnology

U19BT725 – DOWNSTREAM PROCESSING

(Regulation 2019)

Time: Three Hours

Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	List the four stages involved in downstream processing.	2	K2	CO1
2.	Justify why gram positive bacteria require more energy to release the intracellular content?	2	K2	CO1
3.	Critique how the compressibility of the cake alters the filtration characteristics of the broth.	2	K2	CO2
4.	A tubular bowl centrifuge with internal diameter of 15 cm and the length of 80 cm is used for the concentration of genetically engineered <i>Bacillus cereus</i> . Calculate the settling velocity of the cells at the speed of 18000 rpm in the centrifuge with the volumetric capacity of 250 litre per hour.	2	K2	CO2
5.	Summarize the advantages of aqueous two-phase extraction over organic extraction.	2	K2	CO3
6.	Write short note on membrane fouling.	2	K2	CO3
7.	Predict the changes that happen during reverse phase chromatography.	2	K1	CO4
8.	Define retention time in a chromatogram.	2	K2	CO4
9.	Differentiate between bound moisture and unbound moisture content.	2	K2	CO5
10.	State the principle behind freeze-drying.	2	K2	CO5

## PART – B

(5 x 13 = 65 Marks)

Q.No.	Questions	Marks	KL	CO
11. a)	Write a detailed account on the characteristics of biomolecules present in fermentation media.	13	K2	CO1
	(OR)			
b)	Discuss in detail about the various cell disruption methods.	13	K2	CO1
12. a)	Derive the expression for determining the feed flow rate in a tubular bowl centrifuge.	13	K3	CO2
	(OR)			
b)	Elucidate the key factors to be considered while scaling-up of a centrifugation process from lab scale to industrial scale.	13	K3	CO2
13. a)	Fermentation broth enters a continuous mixer settler extraction unit at a flow rate of 100 L/min. This contains 20 g/L antibiotic and its pH has been adjusted to 3.0. Butyl acetate which is used as the extracting solvent enters the extractor at a flow rate of 10 L /min. At pH 3.0 the equilibrium relationship is given by $C_E = 40C_R$ , where $C_R$ and $C_E$ are the antibiotic concentrations in the raffinate and extract respectively and are expressed in g/ L. Calculate: <ol style="list-style-type: none"> <li>The antibiotic concentration in the extract and the raffinate.</li> <li>The fraction of antibiotic extracted.</li> </ol> <p>The organic extract from the first extraction step enters a second continuous mixer settler extraction unit. An aqueous extracting solvent phase at pH 7.0 is fed into this extractor at a flow rate of 5 L /min. At pH7.0 the equilibrium relationship is given by <math>C_E = 37Q</math>, where <math>C_E</math> is the antibiotic concentration in the aqueous extract phase while <math>C_R</math> is the concentration in the organic raffinate phase. Calculate:</p> <ol style="list-style-type: none"> <li>The concentration of the antibiotic in the extract and raffinate from the second extraction.</li> <li>The overall fraction of antibiotic extracted.</li> </ol>	13	K3	CO3
	(OR)			
b)	Explain in detail about the various methods of protein precipitation.	13	K2	CO3
14. a)	Retention time of a compound when analyzed by HPLC was found to be 15.47 minutes. The peak width at the base was 0.75 min. If the length of the column is 30 cm, calculate the number of theoretical plates and plate height. The retention time of a bioproduct when analyzed on a 15 cm length of column by HPLC was found to be 8.23 min. The peak width calculated at half the peak height was 0.18 min. Calculate HETP (Height Equivalent to Theoretical Plates).	13	K3	CO4

(OR)

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|--------|---|----|----|-----|
| b)     | Illustrate and explain in detail about the bio-affinity chromatography with its applications.   | 13 | K3 | CO4 |
| 15. a) | 10 kg of adipic acid is slurried in 13:1 kg of water and heated to 90°C to solubilize the acid. The solution is then filtered to remove the insoluble impurities. During the heating and filtration, 10% of water is evaporated. The clarified solution is then cooled to 35°C and filtered. The solubility at 35°C is 0.05 kg acid per kg water. Determine the weight of crystals recovered in this operation. | 13 | K3 | CO5 |

(OR)

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|----|---|----|----|-----|
| b) | Explain the mechanism of drying and brief about spray drier with its industrial applications. | 13 | K2 | CO5 |
|----|---|----|----|-----|

### PART – C

(1 x 15 = 15 Marks)

- | Q.No.  | Questions   | Marks | KL | CO  |
|--------|---|-------|----|-----|
| 16. a) | Compare the mechanisms and energy profiles of physisorption and chemisorption. Critically evaluate their relative advantages and limitations in heterogeneous catalysis and environmental remediation applications. Propose situations where a combination of both types of adsorption might be essential and defend your choice with chemical and physical principles. | 15    | K4 | CO3 |
| (OR)   |   |       |    |     |
| b)     | Case study: Explain how High-pressure homogenizer is used to disrupt microalgae in Biofuel production.  | 15    | K3 | CO1 |