# BT-303 (Biochemical Engineering)

## End-Semester Examination

**Date: 22.11.2023** **Total Marks: 40** **Duration: 3 h**

Q1: (a) Gas-liquid mass transfer is of great importance in bioprocessing because of the requirement oxygen in aerobic cell cultures. Let us assume that A is transferred from the gas phase into the liquid phase. The concentration of **A** in the liquid is $C_{AL}$ in the bulk and $C_{ALi}$ at the interface. In the gas, the concentration is ~~CAG~~ $C_{AG}$ in the bulk and $C_{AGi}$ at the interface.

Establish the following expression of rate of mass transfer of A :

$$N_A = k_L a(C_{AL}^{*} - C_{AL})$$

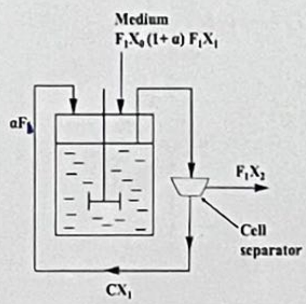
**Show all the steps clearly. Make proper assumption.**

(b) How do you define (with equation) maximum biomass concentration ($x_{max}$)?

(c) What is $(k_L a)_{crit}$?

Marks: 6+2+2=10

**Q2**: In a chemostat with cell recycle as shown in the figure, the feed flow rate and the culture volumes are F = 100 ml/h and V = 1000 ml, respectively. The system is operated under glucose limitation and the yield coefficient $Y_{x/s}$ = 0.5 g cells/g substrate. Glucose concentration in the feed is $S_0$ = 10 g glucose/l. The kinetic constant of the organisms are $\mu^{max}$ = 0.2 $h^{-1}$, $K_s$ = 1 g/l. The value of C is 1.5 and the recycle ratio is α = 0.7. The system is at steady state.




(a) Find the substrate concentration in the recycle stream (S).
(b) Find the specific growth rate of the organism ($\mu_{net}$)
(c) Find the cell concentration (biomass) in the recycle stream.
(d) Find the cell concentration in the centrifuge effluent ($X_2$).

Marks: 2.5x4=10

Q3: For immobilized enzyme catalysed reaction, effect of external mass transfer resistance play a crucial role.

(a) Define Damkohler number ($D_a$). Explain the criteria for diffusion limited regime and reaction limited regime.

(b) What is the effectiveness factor? Explain its physical significance. Explain the changes happens in effectiveness factor and observed reaction rate ($\bar{v}$) when $D_a \rightarrow 0$ *and* $D_a$ *is very large*

Marks: 4+6=10

Q4: For an enzyme catalysed reaction derive the expression for rate of reaction (v) for uncompetitive and non-competitive reactions. Show each step of derivation. Marks: 5+5=10

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