BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : VII**
BRANCH: BIOENGINEERING **SESSION : MO/19**

SUBJECT: BT7023: BIOREACTOR AND BIOPROCESS DESIGN

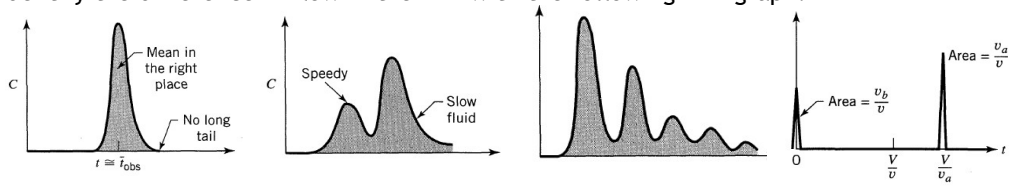
TIME: 3:00 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Name the different types of non-Newtonian fluids. [2]
(b) Write the performance equation of PFR and justify why it is same as performance equation of a batch reactor? [4]
(c) With a suitable schematic diagram describe the different components of a typical batch bioreactor. [6]

Q.2(a) Write the difference between aerobic and anaerobic process with example. [2]
(b) Prove that in a chemostat, at steady state and for sterile feed, μ = D. [4]
(c) With the help of flow diagram illustrate the ethanol production process. [6]

Q.3(a) Write the equation indicating the relation between C curve and E curve. [2]
(b) Identify the difference in flow in the PFR with the following RTD graph: [4]



a b c

d

(c) A 12-m length of pipe is packed with 1 m of 2-mm material, 9 m of 1-cm material, and 2 m of 4-mm material. Estimate the variance in the output C curve for a pulse input into this packed bed if the fluid takes 2 min to flow through the bed. Assume a constant bed void and a constant intensity of dispersion given by $D/ud_p = 2$. [6]

Q.4(a) State the reason for using scale-down approach. [2]
(b) Write the scale-up criteria for a bioreactor. [4]
(c) In an exponentially growing batch culture of *Saccharomyces cerevisiae*, the cell density is 20 g/l (DCW), the specific growth rate (μ) is 0.4 h^{-1} and substrate uptake rate is 16 g/l.h. Calculate the cell yield coefficient $Y_{x/s}$. [6]

Q.5(a) Write the mathematical expression of Monod chemostat model. [2]
(b) Write the name of the different types of valves used in bioreactor. [4]
(c) Describe the methods of determination of K_La for aerobic fermentation. [6]

Q.6(a) Write the difference between biosensor and analytical instrument. [2]
(b) Describe the mechanism and application of biosensors. [4]
(c) Explain different physical parameters used to monitor and control fermenter. [6]

Q.7(a) Which reactor you will prefer when: [2]
i) Product inhibits the process; ii) Substrate inhibits the process; iii) Shear stress causing cell damage; iv) Very large surface area is needed?

PTO

(b) A fed batch culture is operating with intermittent addition of glucose solution. The values of following parameters are given at t = 2 hours. Considering the system is at quasi steady state, calculate V_0, S and X for the system. Given: V = 1000 mL; S_0 = 100 g/L; K_s = 0.1 g/L; X_0 = 30 g; F = 200 ml/h; μ_{max} = 0.3 h^{-1}; $Y_{x/s}$ = 0.5 g/g. [4]

(c) It is desired to produce 100 kg fructose per day in a batch reactor by enzymatic reaction. Initial glucose concentration is 100 g/L. Conversion efficiency is 40%. If, $K_m = 5\times10^{-4}$ kg/m^3, $V_{max} = 1.5\times10^{-2}$ kg/m^3.sec. Down time is 6 h. Calculate the volume of the batch reactor, PFR and MFR. [6]

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