Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS JAN 2021 (REGULAR)

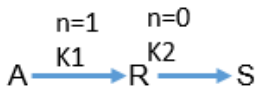
SUBJECT: BIOREACTION ENGINEERING (BIO 3153)

REVISED CREDIT SYSTEM

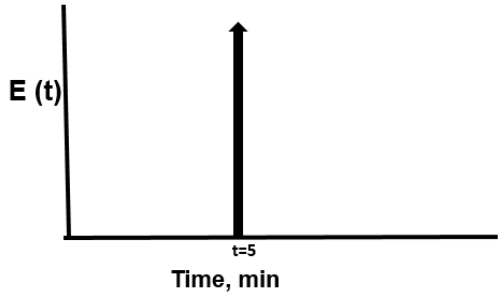
Time: 3 Hours (04/02/2021) MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.	You have been asked to convert sucrose into glucose and fructose using invertase enzyme in a batch fermenter. Explain how do you carry out this reaction as homogeneous and heterogeneous reaction system. Explain both reaction system with respect to productivity and stability of enzyme.	**3**
1B.	Explain how to obtain experimental reaction rate expression for the given reaction system.	**3**
1C.	A zero order gas reaction 2A → 3R proceeds in a batch fermenter with 20% inerts and 10% R in a constant volume batch reactor with initial total pressure of 1 atm. The pressure of the reaction system raised by 30 % in 3 h. If the same reaction is carried out in a variable volume batch reactor for 2 h time what is the fractional change in volume and conversion at this time.	**4**
2A.	For the following First order followed by zero order series reaction that is taking place in a batch fermenter  Prove that (i) $\frac{CR,\max}{CA0} = 1 - K(1 - \ln K)$ (ii) $t\max = \frac{1}{k1}\ln\frac{1}{K}$; where K=k2/(K1C_{A0})	**3**
2B.	The following biochemical reaction is carried out in a batch fermenter with Bacillus species to produce certain product P with stoichiometry 2A + 3B →5P. Researcher has taken 4 M of A and 6 M of B at the start to carry out the above fermentation reaction. Researcher has suspected that above reaction obeys 2nd	**4**

	order reaction kinetics. Substantiate the following batch reactor data to 2nd order kinetics and find the rate equation. 	Time, h	0	4	8	12	16	20	24
---	---	---	---	---	---	---	---
C_P, M	0.1	0.93	1.43	1.88	2.08	2.30	2.49	 C_P= concentration product	
2C	Aqueous biochemical reaction is carried out in a plug flow reactor with v_0=2 liter/min, C_{A0}=100 mmol/liter, C_{R0}=10 mmol/liter. This reaction is reversible and represented by A ⇔ R ,-r_A= (0.04 min^{-1}) C_A - (0.01 min^{-1}) C_R. Find the volume of PFR required to achieve 85 % of maximum possible conversion.	**3**
3A.	Hydrolysis of palm oil is carried out in a PFR with free Lipase enzyme. The Substrate sucrose (S0=4M) is pumped at 0.1 L/h. The enzyme catalyzed reaction follows the Product inhibition kinetics. Find the volume of the reactor to achieve 55% conversion at steady state. Reaction: S→P Kinetics data: Vm=0.028 M/min, Km=0.23 M, KI=0.2 M $-r_s = \frac{V_{max}.S}{(K_M + PK_I) + S}$	**5**
3B.	Three Mixed Flow reactors of volume V1=100 liter, V2=147 liters and V3= 264 liter are connected in series for processing liquid feed at 250 liters/min, C_{A0}=1.2 M. Find the intermediate concentrations C_{A1},C_{A2} and C_{A3} using graphical approach. The kinetic data are obtained from batch reactor and is presented in the following table. 	-r_A, M/min	0.27	0.46	0.64	0.72	0.80	0.82	0.86
---	---	---	---	---	---	---	---
CA, M	0.2	0.4	0.6	0.8	1.0	1.2	1.4		**5**
4A.	An Enzymatic reaction is taking place in a recycle reactor with Michealis-Menten kinetics: $-rs = \frac{Vmax.S}{(KM+S)}$, S=S_0(1-X_A). Prove the condition for optimum recycle ratio as $ln\frac{[Ro(1-XAf)+1]}{[(Ro+1)(1-XAf)]} = \frac{XAf}{Ro(1-XAf)+1}$	**5**
4B.	A particular biochemical product is produced using a free enzyme in a cascade reactor system of MFR & PFR. The substrate concentration at 1 M, v0=1 lit/min is pumped into the cascade reactor system. Volume of MFR is 10 liters and PFR is 0.9 liters. Reaction system follows the Michaelis-Menten kinetics with Vm=0.318 M/min, Km=0.23 M. Which reactor should be used as first reactor to achieve maximum final conversion?	**5**
5A.	Explain the following terminology in continuous fermenter (Chemostat) i. Critical dilution rate ii. Optimum dilution rate iii. Condition for steady state operation of chemostat	**3**

5B.	A liquid macrofluid reacts according to A → R as it flows through a vessel. Find the conversion of A for the following flow pattern and kinetics C_{A0}=4 mol/liter $-r_A = k C_A^2$ k = 1 mol/liter. Min  	**2**
5C	The following data were obtained from a non ideal bioreactor during the RTD experiment using KCl as the tracer material. (i)Plot F-curve (ii) plot E(t) vs t curve (iii) Find the fraction of material coming out from the reactor in the time interval 40 and 60min.	**5**

Time s	0	15	25	35	45	55	65	75	95
Tracer concentration g/cc	0	0.5	1.0	2.0	4.0	5.5	6.5	7.0	7.7