QP Code: SN23BTECH233 Reg. No AY 23

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur (GIET University)

B. Tech (Fifth Semester - Regular) Examinations, November 2025

23BBTOE35011 – Biochemical Reaction Engineering

(Biotechnology)

Time: 3 hrs Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A (2 x 5 = 10 Marks)

Q.1. Answer ***ALL*** questions	CO #	Blooms Level
a. Differentiate between heat of solution and heat of mixing.	CO1	K2
b. Determine the order of a chemical reaction from the given rate law expression, $-r_{O_3} = k[O_3]^2[O_2]^{-1}$.	CO2	K3
c. Calculate volumetric fraction ε_A for a gas phase reaction, $A + Inerts \rightarrow 2R + Inerts$, having 20% inerts in the reactant initially.	CO2	K3
d. What should be the characteristics of an ideal reactor?	CO1	K2
e. Define the term ‘turn over number’ used in Michaelis- Menten kinetics.	CO2	K3

PART – B (10 x 5 = 50 Marks)

Answer ***ALL*** the questions — Marks — CO # — Blooms Level

2. a. An single effect evaporator is fed with 10000 kg/h of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight (NaOH). Calculate the — 5 — CO2 — K4

(a) kg/h of water evaporated

(b) kg/h thick liquor

b. Calculate the std heat of formation of ethane gas at 25 ^{0}C using the following data. — 5 — CO2 — K3

Heat of formation of $CO_{2(g)}$ = -393.5 kJ/mol

Heat of formation of $H_2O_{(l)}$= -285.8 kJ/mol

Heat of combustion of $C_2H_{6(g)}$= -1560.7 kJ/mol

(OR)

c. Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene is fed to the reactor and the product is found to contain 80 kmol of ethylene oxide and 10 kmol of CO_2. Calculate — 5 — CO2 — K4

(a) the percent conversion of ethylene and

(b) percent yield of ethylene oxide

d. Obtain the empirical equation for calculating the heat of reaction at any temperature T (K) for the following reaction: — 5 — CO3 — K3

$$SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}$$

Data: Standard heat of formation of SO_3 is -395720 kJ/kmol

Standard heat of formation of SO_2 is -296810 kJ/kmol

Component	a	bx10^3	C x10^6
SO_3	22.036	121.624	-91.867
SO_2	24.771	62.948	-44.258
O_2	26.026	11.755	-2.343

$$C_p^0 = a + bT + cT^2, \text{ kJ/(kmol.K)}$$

Using the same expression, calculate the heat of reaction at 750 ^{0}C.

3.a. Discuss the different types of intermediates used in chemical reactions. 4 CO1 K2

b. A rocket mixture burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen). The combustion chamber is cylindrical, 75cm long and 60 cm in diameter and the combustion process produces 108 kg /sec of exhaust gases. If the combustion is complete, find the rate of reaction of hydrogen and of oxygen. 6 CO2 K3

(OR)

c. For the following stoichiometry, find the overall order of the reaction $A + B \rightarrow Products.$ Given 5 CO2 K3

C_A	2	2	3
C_B	125	64	64
$-r_A$	50	32	48

d. In a certain Kinetic study, the rate constants were found to vary with temperature in the following manner. 5 CO2 K4

$K \times 10^3$ (min^{-1}):	4.15	26.8	114	246
T (K) :	573	600	623.5	635

Evaluate the activation energy & Arrhenius constant.

4.a. Derive the performance equation for irreversible first order reaction of constant-volume batch reactor. 5 CO2 K3

b. Liquid A decomposes by first-order kinetics, and in a batch reactor 50% of A is converted in a 5-minute run. How much longer would it take to reach 75% conversion? 5 CO2 K3

(OR)

c. Derive an expression for C_{Rmax}, in a series reaction of A → R → S, with the rate constants for first order reactions k_1 and k_2 . 10 CO2 K4

5.a. Derive the design equation for batch reactor from material balance equation. 5 CO2 K3

b. A zero order reaction (A → R) with rate constant 10 occurs in a plug flow reactor. Find the volume required to achieve 90 % conversion with initial concentration of reactant 100 mol/lit and volumetric flow rate of reactant 25 lit/min. 5 CO3 K4

(OR)

c. Describe the characteristics of a batch reactor with diagram. Also write its advantages, disadvantages and applications. 5 CO1 K2

d. Gaseous reactant A decomposes as follows. 5 CO2 K3

$$A \rightarrow 3R, \ -r_A = 0.6\ min^{-1} C_A$$

Find the space time and conversion of A in 50% A-50% inert feed having a flow rate of 180 lit/min and C_{A0}=300 mol/lit, to a 1 m^3 mixed flow reactor

6.a. Mention the factors affecting the enzyme activity. 2 CO1 K2

b. Derive Michaelis-Menten equation for the enzyme catalyzed reaction $S + E \rightarrow E + P.$ 8 CO2 K3

(OR)

c. Differentiate reversible and irreversible inhibition. 2 CO1 K2

d. Beef lever catalyst has been used to accelerate the decomposition of H_2O_2 to yield water and oxygen. The concentration of H_2O_2 is given as a function of time for a certain mixture with pH = 6.76 and maintained at 30^0C. 8 CO2 K4

t (min)	0	10	20	50	100
H_2O_2, (mol/lit)	0.02	0.0178	0.0158	0.0106	0.005

Determine the maximum reaction velocity and Michaelis- Menten constant.

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