Q. Code: 759592

Reg. No. | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Seventh Semester

CH16705 – CHEMICAL REACTION ENGINEERING II

(Chemical Engineering)

(Regulation 2016)

Time: Three Hours **Maximum : 100 Marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

		CO	RBT
1.	Define: Supported catalyst with example.	1	U
2.	Differentiate: Catalyst bed voidage and catalyst pore voidage.	1	U
3.	Explain: Dissociative Adsorption	1	U
4.	Write the rate equation for Eley Rideal Mechanism.	3	U
5.	Define Thiele Modulus.	2	U
6.	Explain: Overall effectiveness factor.	2	U
7.	List the models available to describe the gas solid non catalytic reaction?	2	R
8.	State the advantages of fluidized bed reactors.	2	U
9.	Mention the basic assumptions of Penetration Theory.	3	U
10.	Specify the limitations of E_i for pseudo 1st order and instantaneous reactions.	3	U

PART B - (5 X16 = 80 Marks)

11. (a) Derive an expression for the critical pore radius of a catalyst. Also derive an equation to estimate the average pore radius of a cylindrical pore of length 'L' and Radius 'R'. **(16)** **1** **U**

(OR)

(b) An 8.01 g sample of Glucosil is studied with N2 adsorption at –195.8 ºC. The following data are obtained: **(16)** **1** **AP**

Pressure (mm Hg)	6	25	140	230	285	320	430	505
Volume adsorbed, cm^3at 0ºC and 1 atm:	61	127	170	197	215	280	277	335

The vapour pressure of N_2 at -195.8°C is 1 atm. Estimate the surface area (square meters per gram) of the sample.

12. (a) Determine the rate equation for cumene decomposition reaction assuming (a) Adsorption to be rate controlling and (b) surface reaction to be rate controlling. **(16)** **3** **AP**

(OR)

(b) Consider a solid catalyzed reaction A+B $\longrightarrow$ R + S. Assuming Langmuir-Hinshelwood model, derive the kinetic Rate equation. Assume Surface reaction to be rate controlling. **(16)** **3** **AP**

13. (a) Derive the effectiveness factor for an isothermal first order reaction with a rectangular catalyst pellet. **(16)** **2** **U**

(OR)

(b) A first order catalytic reaction A $\longrightarrow$ R is carried out in a packed bed reactor. The molal feed rate of the reactant is 12.5 kmol/hr. The following data is available; **(16)** **2** **AP**

W (kg cat)	0.625	1.87	3.125	4.375	6.25	7.5	8.75
X_A	0.058	0.139	0.213	0.288	0.381	0.440	0.493

Calculate the weight of the catalyst for 40% conversion in a packed bed reactor, if the molal feed rate is increased to 125 kmol/hr.

14. (a) Derive the relationship between Time and Conversion when Diffusion through ash layer controls a fluid-Solid reaction as per the shrinking core model. Also, show that the time 'τ' required for complete burning of the solid particle is proportional to the square of the radius 'R'. **(16)**

(OR)

(b) A feed consisting of 30% of 50μm, 40% of 100μm, and 30% of 200μm particles is to be fed continuously in a thin layer onto a moving grate cross-current to a flow of reactant gas. For the planned operating conditions the time required for complete conversion is 5, 10, and 20 minutes for the three sizes of particles. Find the conversion of solids for a mean residence time of 8 minutes in the reactor. **(16)** **2** **AP**

15. (a) Derive the rate equation for fluid-fluid reaction for the following cases; **(16) 4 U**

(i) Fast reaction in Liquid film with Low CB

(ii) Fast reaction in Liquid film with High CB

Sketch the concentration profiles of the reactants for these reactions.

(OR)

(b) Hydrogen sulfide is absorbed by a solution of methanolamine (MEA) in a packed column. At the top of the column, gas is at 20 atm and it contains 0.1% of H_2S, while the absorbent contains 250 mol/m^3 of free MEA. The diffusivity of MEA in solution is 0.64 times that of H_2S. The reaction is normally regarded as irreversible and instantaneous. **(16) 4 AP**

$$H_2S(A) + RNH_2(B) \longrightarrow HS^- + RNH^{3+}$$

For the flow rates and packing used

- $k_{Al}\,a = 0.032\ s^{-1}$
- $k_{Ag}\,a = 60$ mol/m^3-s-atm
- $H_A = 1 \times 10^{-4}$ m^3-atm/mol, Henry's law constant for H_2S in water.

(i) Find the rate of absorption of H_2S in MEA solution.

(ii) To find out whether it is worthwhile using MEA absorbent, determine how much faster absorption is with MEA compared to absorption in pure water.