Hall Ticket No : **Question Paper Code :**

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)

III/IV B. Tech I- Semester Regular Examinations Nov - 2017

Chemical Engineering Thermodynamics – II

(CHEMICAL)

Time: 3 hours **Max Marks: 60**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT - I

1) a) Discuss the characteristics of refrigerant to be used in refrigeration. **(4M)**

b) A refrigeration system requires 1.5 kW of power for a refrigeration rate of 4 kW. **(8M)**
(i) What is the coefficient of performance?
(ii) If heat rejection is at 313.15 K, what is the lowest temperature the system can possibly maintain?

(OR)

2) a) Explain the working of a heat pump. **(4M)**

b) With a neat sketch describe in detail about the Claude liquefaction process. **(8M)**

UNIT – II

3) a) With a neat sketch explain in detail about the vapour-liquid-liquid equilibrium and solid vapour equilibrium. **(6M)**

b) For the system ethyl ethanoate (1) / n-heptane (2) at 343.15 K assuming modified Raoult's law calculate: **(6M)**
(i) BUBL P calculation for x_1=0.05.
(ii) DEW P calculation for y_1=0.05.
Data: $\ln \text{¥}_1 = 0.95x_2^2$ $\ln \text{¥}_2 = 0.95x_1^2$ $P_1^{sat} = 79.80kPa$ $P_2^{sat} = 40.50kPa$

(OR)

4) a) Write short notes on flash calculations. **(4M)**

b) Assuming Raoult's law, prepare P-x-y diagram for a temperature of 363.15 K for Benzene (1) / ethylbenzene (2) system. **(8M)**

Antoine equation parameters	*A*	*B*	*C*
Benzene	13.8594	2773.78	-53.08
Ethylbenzene	14.0045	3279.47	-59.95

MODEL PAPER

UNIT - III

5) a) Discuss in brief about excess properties. **(4M)**

b) The molar volume (cc/mol) of a binary liquid mixture at T and P is given by $V=120x_1+70x_2+(15x_1+8x_2)x_1x_2$ **(8M)**

(i) Find expressions for the partial molar volumes of species 1 and 2 at T and P.

(ii) Show that these expressions satisfy Gibbs / Duhem equation.

(iii) show that $\left(\frac{d\bar{V}_1}{dx_1}\right)_{x_1=1} = \left(\frac{d\bar{V}_2}{dx_1}\right)_{x_1=0} = 0$

(OR)

6) a) Discuss on enthalpy, entropy and Gibbs energy for an ideal gas mixtures. **(6M)**

b) Explain in detail about fugacity and fugacity coefficient for species in solution. **(6M)**

UNIT - IV

7) a) Write short notes on thermodynamic consistency. . **(5M)**

b) Discuss in detail about the property changes of mixing. **(7M)**

(OR)

8) The following is the set of VLE data for the system methanol (1) / water (2) at 333.15 K. Calculate the parameter values for the Margules equation. **(12M)**

P/kPa	19.95	42.98	52.78	60.61	67.92	72.83	84.562
x_1	0	0.216	0.368	0.528	0.680	0.777	1
y_1	0	0.626	0.734	0.808	0.873	0.914	1

UNIT - V

9) a) Write short notes on application of equilibrium criteria to chemical reactions. **(4M)**

b) Develop expressions for mole fractions of reacting species as functions of the reaction coordinate for **(8M)**

(i) A system initially containing 2 mol NH_3 and 5 mol O_2 and undergoing the reaction

$$4NH_3(g)+5O_2(g)\rightarrow 4NO(g)+6H_2O(g)$$

(ii) A system initially containing 3 mol H_2S and 5 mol O_2 and undergoing the reaction

$$2H_2S(g)+3O_2(g)\rightarrow 2H_2O(g)+2SO_2(g)$$

(OR)

10) a) Derive an expression for equilibrium constant in terms of composition for liquid phase reactions. **(6M)**

b) For ammonia synthesis reaction $\frac{1}{2}N_2(g)+\frac{3}{2}H_2(g)\rightarrow NH_3(g)$ with 0.5 mol N_2 and 1.5 mol H_2as the initial amounts of reactants and with the assumption that the equilibrium mixture is an ideal gas, show that $\pounds_e = 1-\left(1+1.299K\frac{P}{P^o}\right)^{-1/2}$ **(6M)**

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ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)
III/IV B. Tech I- Semester Regular Examinations Nov - 2017

Chemical Reaction Engineering-I

(CHEMICAL)

Time: 3 hours **Max Marks: 60**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1) a) Discuss the differences between order and molecularity of the reaction. **(4M)**

b) Show that the following scheme is consistent with and can explain the observed first order decomposition of N_2O_5 **(8M)**

$$N_2O_5 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NO_2 + NO_3^*$$

$$NO_3^* \xrightarrow{k_3} NO^* + O_2$$

$$NO^* + NO_3^* \xrightarrow{k_4} 2NO_2$$

(OR)

2) a) Discuss the temperature dependence of rate constant based on Arrhenius law and collision theory **(4M)**

b) The kinetics of enzyme-substrate reactions are explained by Michaelis-Menten by an equilibrium assumption with $K = \frac{[X]}{[A][E]}$ and with $[E_0] = [E] + [X]$ where $[E_0]$ represents the total enzyme concentration and $[E]$ represents the free unattached enzyme. Obtain the final rate form $-r_A$ in terms of substrate concentration $[A_0]$, initial enzyme concentration $[E_0]$, rate constants k_1 (the forward constant for the reaction between substrate and enzyme), rate constant k_2 (the backward reaction i.e. the decomposition of enzyme-substrate complex to enzyme and substrate), and k_3 the rate constant for decomposition of enzyme-substrate complex to enzyme and product. **(8M)**

UNIT – II

3) a) Define fractional conversion in terms of concentration and half life in terms of concentration and rate constant for n^{th} order. **(4M)**

b) Aqueous A reacts to form R according to the stoichiometry, $A \rightarrow R$ with $C_{Ao} = 2 mol/l$. The conversion is 80% in 8 min and 90% in 18 min. Find the rate equation to represent the data. **(8M)**

(OR)

4) a) What do you understand by interpretation of batch reactor data? **(4M)**

b) Find a rate expression to represent the following data **(8M)**

t, min	0	100	200	300	400	500
$C_{A,}$ mol/l	1000	500	353	250	200	167

UNIT - III

5) a) Define space time and space velocity and what is the relation between them? **(4M)**

b) A mixed flow reactor ($4m^3$) processes an aqueous feed (200 l/min) containing A (C_{A0} = 100 mol/l). The reaction is reversible and is represented by

$$A \Leftrightarrow B \qquad -r_A = 0.04C_A - 0.01C_B$$

Find the equilibrium conversion and actual conversion of A in the reactor. **(8M)**

(OR)

6) a) Write down the characteristics of plug flow reactor. . **(4M)**

b) The following data are obtained for the reaction $A \rightarrow R$ in a batch reactor

C_A (mol/l)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3
$-r_A$	0.1	0.3	0.5	0.6	0.5	0.25	0.10	0.06	0.05	0.045

What size of plug flow reactor would be needed for 80% conversion of a feed stream of 2000 mol/h and C_{A0}=1.5 mol/l **(8M)**

UNIT - IV

7) The kinetics of the aqueous phase decomposition of A investigated in two mixed flow reactors in series, the second having twice the volume of the first reactor. At the steady state, the concentration of the feed is 2 mol/l, in the first reactor it is 1.0 mol/l and in the second reactor it is 0.5 mol/l and the mean residence time is 100 s in the first reactor. Find a kinetic expression to represent the data **(12M)**

(OR)

8) At present the elementary liquid phase reaction $A + B \rightarrow R + S$ takes place in a plug flow reactor with $C_{A0} = C_{B0} = 2 mol/l$ and the conversion is 90%. If a mixed flow reactor 10 times as large as the plug flow reactor were hoked up in series with the existing unit, which unit should come first and by what fraction could production be increased for that set up? **(12M)**

UNIT - V

9) Discuss the quantitative treatment about product distribution and of reactor size in plug flow reactor, mixed flow reactor for a series reactions. **(12M)**

(OR)

10) a) Define selectivity and what are the values of τ m,opt and C Rmax for a mixed flow reactor, if $k_1 = k_2 = k$? **(4M)**

b) The series reaction $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ proceeds with a volumetric rate of A 100 l/min in which C_{A0} = 1 mol/l, C_{R0} = C_{S0} =0. What size of the plug flow reactor will maximize the concentration of R and what is the maximum concentration of R in the effluent stream? Take $k_1 = 0.1/\min$ *and* $k_2 = 0.2/\min$ **(8M)**

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Hall Ticket No : **Question Paper Code :**

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)

III/IV B. Tech I- Semester Regular Examinations Nov - 2017

Heat Transfer

(CHEMICAL)

Time: 3 hours **Max Marks: 60**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

Unit -1

1. (a) Derive an expression for steady state heat conduction through a composite slab. **(6M)**

(b) A Furnace is constructed with a 229 mm thick layer of fire brick, a 115 mm thick layer of insulation brick and again a 229 mm thick layer of building brick. The inside temperature is 1223 K and the temperature at the outermost wall is 323 K. The thermal conductivities of the fire brick, insulating brick, and building brick are 6.05, 0.581 and 2.33 W/(m.K) respectively. Find the heat lost per unit area and temperature at the interface. **(6M)**

(OR)

2. (a) Explain Fourier's law of heat conduction. **(4M)**

(b) A steam pipe 170/160 mm in diameter is covered with two layers of insulation. The thickness of 1^{st} layer is 30mm and that of second layer is 50mm. The temperature of inner surface of a steam pipe is 300^0C and that of outer surface of insulation is 50^oC. Determine the quantity of heat loss per meter of length of steam pipe and also layer contact temperature. k_1 = 50 W/m-K, k_2 = 0.15 W/m-K, k_3= 0.08 W/m-K. **(8M)**

Unit – 2

3.(a) What is convection? What are the various correlations used to calculate film coefficient in forced convection without phase change? **(4M)**

(b) Calculate the heat transfer coefficient for fluid flowing through the tube having inside diameter 40 mm at a rate of 5500 kg/h. Assume that the fluid is being heated. Data: Properties of fluid at mean bulk temperature: Viscosity of flowing fluid = 0.004 (N.s)/m^2
Density of flowing fluid = 1.07 g/cm^3
Specific heat of flowing fluid = 2.72 kJ/(kg.K)
Thermal conductivity of flowing fluid = 0.256 W/(m.K)
Note: Make use of Dittus – Boelter equation **(8M)**

(OR)

4. (a) Derive the relationship between individual and overall heat transfer coefficie

(b) What is the difference between drop wise and film type condensation in heat transfer to fluids with phase change? Which is more effective mechanism of heat transfer ? Why? **(6M)**

MODEL PAPER

Unit – III

5. (a) State and explain Kirchoffs and Wein's laws of thermal radiation. **(4M)**

(b) Two large grey surfaces, having emmissivities of 0.8 and 0.5 are at 400 ^{0}C and 100 ^{0}C respectively.Calculate the heat transfer rate by radiation per square meter, if the surfaces are (a) parallel plates,

and (b) concentric cylinders. Stefan – Boltzman constant is 5.6×10^{-8} W/(m^2.K^4). **(8M)**

(OR)

6. (a) Derive an expression radiating heat exchange between two nonblack surfaces. **(6M)**

(b) Calculate the net radiant interchange per square meter for very large planes at temperature

of 703K and 513 K respectively. Assume that the emmisivity of the hot and cold plane are 0.85 and 0.75 respectively

Data: Take emissivity = 0.85 and Stefan – Boltzman constant is 5.6×10^{-8} W/(m^2.K^4) and film coefficient (h_c) for heat loss by natural convection can be calculated by $h_c = 1.64 (\Delta)^{0.25}$, W/(m^2.K). **(6M)**

Unit – IV

7. Write short notes on (i) Shell and tube heat exchangers **(6M)**
(ii) Method of effectiveness of heat exchangers **(6M)**

(OR)

8. Write short notes on (i) Plate type heat exchangers **(6M)**
(ii) Scraped surface heat exchanger **(6M)**

Unit – V

9. (a) Define capacity and economy of evaporators **(6M)**

(b) A single effect evaporator is to concentrate 20000 kg/hr of a solution having a concentration of 5% salt to a concentration of 20% salt by weight. Steam is fed to the evaporator at a pressure corresponding to the saturation temperature of 399K.The evaporator is operating at atmospheric pressure and boiling point rise is 7K.Calculate the heat load and steam economy.

Data: Feed temperature = 298K

Specific heat of feed = 4 kJ/kg

Latent heat of condensation of steam at 399K= 2185 kJ/kg

Latent heat of vaporization of water at 373K= 2257 kJ/kg. **(6M)**

(OR)

10 (a) Write short notes on multiple effect evaporators and give an explanation how they are superior over a single effect evaporator. **(6M)**

(b) Discuss the different types of evaporators with neat sketches. **(6M)**

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III/IV B. Tech I- Semester Regular Examinations Nov - 2017

Mass Transfer-I

(CHEMICAL)

Time: 3 hours **Max Marks: 60**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1) a) State Fick's law of diffusion and discuss its importance. **(3M)**
   b) In an A-B gas mixture at 1 std atm, 25^0C, the concentration of A at two planes 4mm apart are 30 and 40 vol % respectively. Calculate the flux of diffusion of the '**A**' for the case where there is equimolal counter diffusion of two gases and diffusion of A through non diffusing B. **(9M)**

(OR)

2) a) Write the applications of molecular diffusion. **(4M)**
   b) Starting with the basic equations for mass flux of a component in a binary gas mixture, derive the expressions for steady state diffusion of A through non-diffusing B and equimolar counter diffusion. **(8M)**

UNIT – II

3) Discuss about interphase mass transfer with a neat diagram and derive relationship between overall mass transfer coeffecients to local mass transfer coeffecients. **(12M)**

(OR)

4) a) Discuss between heat and mass transfer analogies? **(3M)**
   b) Discuss briefly different types of solid diffusion? **(3M)**
   c) Explain in detail about different mass transfer theories developed to explain mass transfer at fluid surfaces? **(6M)**

UNIT - III

5) a) A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent and the light oil recovered by stripping the resulting solution with steam. The circumstances are as follows.

   Absorber: Gas in 0.250 m^3/s at 26^0C, P_t= 1.07 x 10^5 N/m^2 containing 2% by volume of light vapors. The light oil will be assumed to be entirely benzene and a 95% removal is required . The wash oil is to enter at 26^0C , containing 0.005 mole fraction benzene, and has an average molecular weight 260. An oil circulation rate of 2.5 times the minimum is used. The vapor pressure of benzene at given temperature is 13330 N/m^2 .Calculate the oil circulation rate and terminal compositions **(12M)**

(OR)

6) a) Discuss the choice of solvent in absorption. **(4M)**
   b) Derive the relationship between HETP, HTU and NTU. **(8M)**

UNIT - IV

7) 1000 kg moles/hr of an ethanol-proponal mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating at 1 atmosphere total pressure. The desired terminal compositions in units of molefraction of ethanol are 0.92 in distillate and 0.07 in residue. The reflux ratio is 4.0. The feed is at its saturated liquid. The relative voltality is 2.10. Find the number of theoretical plates using Mc-Cabe-Thiele method. **(12M)**

(OR)

8) a) Discuss extractive and azeotropic distillation. **(5M)**
   b) Write the material balance on enriching section, exhausting section and feed tray location and derive equation for each section using Mc-Cabe Thiele method assumptions. **(7M)**

UNIT - V

9) a) Discuss the differences between tray and packed tower. **(6M)**
   b) Sketch Venturi Scrubber and explain its working. **(6M)**

(OR)

10) a) Discuss the importance of cooling tower and its various types in detail. **(8M)**
    b) Define coning, weeping, flooding, dumping. **(4M)**

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ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)

III/IV B. Tech I- Semester Regular Examinations Nov - 2017

POLYMER TECHNOLOGY

(Open Elective)

Time: 3 hours **Max Marks: 60**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT - I

1) a) Discuss the following **(4M)**
   (i) Natural Polymer
   (ii) Co-polymer
   b) Explain the classification of polymers in detail. **(8M)**

(OR)

2) a) Write in detail about colligative methods to determine molecular weight of polymers. **(6M)**

   b) Describe gel chromatographic method **(6M)**

UNIT – II

3) Elaborate elementary concepts of addition and condensation polymerization. **(12M)**

(OR)

4) a) Enumerate the degradation of polymers due to mechanical and thermal effects. **(4M)**

   b) What is glass transition temperature of polymers and explain the methods of determining T_g **(8M)**

UNIT - III

5) a) Explain mass and solution polymerization **(6M)**

   b) Write short notes on . **(6M)**
   (i) Role of initiators
   (ii) Fillers
   (iii) Plasticizers

(OR)

6) List out the materials used in the methods of polymerization explaining their effects in the polymerization process. **(12M)**

MODEL PAPER

UNIT - IV

7) a) What are addition products? Explain the manufacturing and applications of the following.
(i) PVC (ii) PTFE **(12M)**

(OR)

8) Discuss properties and manufacturing methods of following condensation products **(12M)**
(i) UF resin
(ii) PET
(iii) PMMA

UNIT - V

9) a) Describe mixing and compounding methods for obtaining polymeric compounds. **(6M)**
b) Write the manufacturing process of extrusion and calendaring with the principles involved and equipment used. **(6M)**

(OR)

10) a) Write in detail about **(12M)**
(i) Moulding and compression
(ii) Injection and blow moulding

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