[4363]-211

T. E. Chemical Examination - 2013

Chemical Engineering

Mathematics

(2008 Pattern)

Total No. of Questions : 12 **[Total No. of Printed Pages :4]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answers to the **two sections** should be written in **separate answer-books**.*

(2) Neat diagrams must be drawn wherever necessary.

(3) Black figures to the right indicate full marks.

(4) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(5) Assume suitable data, if necessary.

SECTION I

Q.1] (a) A compound material balance around a chemical reactor yields the following steady state equation:

$$O=\frac{f}{v}\ C_{in}-\frac{f}{v}C - KC^{2.5}$$

Where $f/v = 0.1\ min^{-1}$, $C_{in} = 1.0 Kg/mol/m^3$

$K = 0.05 m^{4.5}/Kg\ mol^{1.5}\ min$

Perform 4 iterations of Newton Raphson method using an initial guess C = 1.0 [10]

(b) State and explain the graphical interpreation of secant method [8]

OR

Q.2] (a) Use secant method to find the root of the equation $cos\ x - xe^x = 0$.
Use initial guess $x_{1=0}$ and $x_{2=1}$ to obtain accuracy of 0.01 [10]

(b) State and explain graphical interpreation of false position method. [8]

Q.3] (a) Solve following system of equation using LU decomposition method [8]

$$2x + 3y + z = 9$$

$$x + 2y + 3z = 6$$

$$3x + y + 2z = 8$$

(b) Find the solution of the following systems of equations using Gauss-Seidal Method and perform five iterations. [8]

$$x_1 - \frac{1}{4}x_2 - \frac{1}{4}x_3 = \frac{1}{2}$$

$$-\frac{1}{4}x_1 + x_2 - \frac{1}{4}x_4 = \frac{1}{2}$$

$$-\frac{1}{4}x_1 + x_3 - \frac{1}{4}x_4 = \frac{1}{4}$$

$$-\frac{1}{4}x_2 - \frac{1}{4}x_3 + x_4 = \frac{1}{4}$$

OR

Q.4] (a) Discuss in short the drawbacks of Elimination methods. [8]

(b) Apply Cholesky decomposition to the symmetric matrix. [8]

$$A = \begin{bmatrix} 6 & 15 & 55 \\ 15 & 55 & 225 \\ 55 & 225 & 979 \end{bmatrix}$$

Q.5] (a) It has been observed that the rate of flow of water through a fire engine hose is a quadratic in pressure P, at the nozzle end. The observed data is

Q	9.4	11.8	14.7	18.0	23.0
P	1.0	1.6	2.5	4.0	6.0

Fit a parabola in the form $Q = ap^2 + bp + c$ by least square method. [8]

(b) Explain Quantification of error of linear regression. [8]

OR

Q.6] (a) From the following table, find the value of $e^{1.17}$ using Gauss's forward formula. [8]

x	1.00	1.05	1.10	1.15	1.20	1.25	1.30
e^x	2.7183	2.8577	3.0042	3.1582	3.3201	3.4903	3.6693

(b) State the algorithm for polynomial regression. [8]

SECTION II

Q.7] (a) Explain graphical interpreation of effect of step size on Euler's method. [8]

(b) Using 4th order Runge Kutta method solve $y'' = xy'^2 - y^2$.For x=0.2 correct upto 4 decimal places. Initial conditions are $x = 0, y = 1, y' = 0$.
The step size h = 0.2 [8]

OR

Q.8] (a) Using Euler's method, find an approximate value of y for $\frac{dy}{dx} = x - y^2$,
for given boundry conditions, $x = 0, y = 1$, find y at $x = 4$.
Take step size h = 1. [8]

(b) Discuss the stability region of Runge-Kutta method. [8]

Q.9] Solve $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, for the following conditions using Schmidt method at $x = 0$ and $x = 0.5, u = 1$ for all values of t at $t = 0, u = 2x + 1$ for $0 < x < 0.5$. Take increment in x as 0.1 and increment in t as 0.01.
Find all values of u for t = 0 to t = 0.03. [16]

OR

Q.10] Discuss in detail the algorithm and flow chart to generate forward differences. [16]

Q.11] (a) What are the six steps of optimization. [6]

(b) How one dimensional search is applied in a multidimensional problem. [12]

OR

Q.12] (a) Explain numerical methods for optimizing a function of one variable. [9]

(b) Explain scanning and bracketing procedures for optimization of unconditional functions of one dimensional search. [9]

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T. E. CHEMICAL ENGGINEERING

Examination - 2013

MASS TRANSFER-I

(2008 Pattern)

Total No. Of Questions: 12 **[Total No. Of Printed Pages: 4]**

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

*(1) Answer **three questions** from section 1 and 3 questions from sections 2*

*(2) Answers to the **two sections** should be written in **separate books**.*

(4) Neat diagrams must be drawn wherever necessary.

(5) Use of logarithmic tables, slide rule, Molliercharts, electronic pocket calculator and steam tables is allowed.

(6) Assume suitable data, if necessary.

SECTION-1

Q. 1. A) What is mass transfer? Define molecular diffusion and Fick's Law of diffusion. (6)

B) Explain the choice of separation methods. (6)

C) In the Oxygen-Nitrogen mixture at 10 atm and 25˚C and (6)

Concentrations of oxygen at two places of 0.2cm apart are 10 and 20 volume percent respectively. Calculate the rate of diffusion of Oxygen expressed as gm per cm^2. hr for the case of unicomponent Diffusion. Value of diffusivity between oxygen-nitrogen=0.181cm^2/sec. R= 82.06 atm.cm^3/gm mole k.

OR

Q. 2. A) Ammonia is diffusing through an inert air film 2mm thick at a (10)
Temperature of 20˚C and pressure of 1 atm. The concentration of
Ammonia is 10% by volume on one side of the film and zero on the
Other side. Determine the mass flux. Estimate the effect on the rate
Of diffusion if the pressure is increased to 10 atm. The diffusivity of
Ammonia in air at 20˚C and 1 atm is 0.185 cm^2/sec

B) Derive the expression to calculate the flux of: (8)

i. Diffusion of gas A through non-diffusion stagnant gas
ii. Equimodal counter diffusion of gases A and B

Q. 3. A) Explain film theory and surface renewable theory. (8)

B) Ammonia is absorbed by water in wetted wall column using (8)
Operating temperature of 20˚C and 1 atm pressure. The overall
Coefficient is 2.72×10^{-4}kmol/m^2 atm. At one point in the column the
Gas contained 10 mol% ammonia and the liquid phase concentration
Was 6.42×10^{-2} kmol ammonia per m^3 of solution. Temperature is
20˚C and 1atm pressure. 85% of the resistance to mass transfer lies
In a gas phase. If Henry's law constant is 9.35×10^{-3} atm m^3/kmol,
Calculate the individual film coefficient and the interfacial composition.

OR

Q. 4. A) Air flow through cylindrical tube made of naphthalene at velocity (8)
Of 5m/s. the diameter of tube is 0.1m and temperature of air 293K.
Using correlation proposed by Gilliand and Sherwood, calculate the
Mass transfer coefficient for transfer of naphthalene to air.
Data: viscocity of air $=1.8 \times 10^{-5}$kg/ms
Density of air=1.2kg/m^3

Diffusivity=4.24 $\times 10^{-6}$ m^2/sec.

B) Derive relation between overall and individual mass transfer resistance (8)

Q. 5. A) Explain absorption with chemical reaction. (6)

B) Ammonia is to be removed its mixture with air by scrubbing with Water in a packed tower. A gas mixture entering the column contains 6% NH_3(vol). Water free of NH_3 enters in the column in countercurrent Direction. If 90% of the ammonia is to be removed using NH_3 free water At the rate of 2 mole water per mole of air. Determine the exit Concentration of ammonia. The gas liquid equilibrium relationship Is y=0.08x, where, y=moles of NH_3 /mole of air, x=moles of NH_3 /mole Water. (10)

OR

Q. 6. A) What are the factors to be considered for selecting solvent for Absorption. (6)

B) Derive an expression for calculating packed tower height. (8)

C) Define HETP (2)

SECTION-2

Q. 7. A) An air-water sample has DBT 50˚C and WBT 35˚C. Using humidity Chart, calculate, i) absolute humidity, ii) dew point, iii) humid heat, iv) % relative humidity, v) enthalpy of saturated air, vi) humid volume. The total pressure of air at 50˚C is 0.1234 $\times$ 10^5 N/m^2, latent heat of Liquid is 2502kJ/kg. (10)

B) What are the uses of cooling towers? Explain any one in brief (6)

OR

Q. 8. A) Define following terms i) Absolute humidity, ii)wet bulb Temperature, iii) adiabatic saturation temperature, iv) enthalpy, v) humid volume, vi) percentage saturation humidity. (12)

B) An air-water vapour mixture at 1 atm has a dry bulb temperature of 64.5˚C. if latent heat of liquid= 579.4Kcal/kg ant saturation humidity at 31.1˚C is 0.031 and air humidity is 0.018 calculate the psychrometric Ratio. (4)

Q. 9. A) What are the various equipments used for gas-liquid contact. With Neat sketch explain a) Wetted Wall Column, b) Mechanically Agitated Vessels, (8)

B) What are the different types of packing used in separation towers? Give Classification. (4)

C) Write short notes on a)Flooding and loading conditions (4)

OR

Q. 10. A) Differentiate between tray columns and packed columns. (4)

B) Explain the end effects of axial mixing. (4)

C) Define the following terms i) Murphree tray efficiency , ii) ideal Tray, iii) overall tray efficiency, iv) Gas holdup and liquid holdup (8)

Q. 11. A) A wet solid is to be dried from 35% to 10% moisture under constant Drying condition in five hours. If the equilibrium moisture content is Is 4% and critical moisture content is 14% how long it will take to Dry solids to 6% moisture under same conditions?(All moisture are on Wet basis) (8)

B) Give classification of drying equipments and working of fluidized Bed dryer. (8)

C) Give uses of drying operation. (2)

OR

Q. 12. A) A sheet material measuring $1m^2$ and 5cm thick, is to be dried from 45% to 5% moisture under constant drying conditions. The dry density Of material is $450kg/m^3$ and equilibrium moisture is 2%. The available Drying surface is $1m^2$. Experiments showed that the rate of drying was Constant at 4.8 kg/m^2hr between 45% to 20% and thereafter the rate is Decreased linearly. Calculate the total time required to dry the material From 45% to 5%. All moisture contents are on wet basis. (8)

B) Derive the equation required for calculating the total time of dying.[10]

[Total No. of Questions: *12*] **[Total No. of Printed Pages:** *4*]

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[4363]-220

T. E. (*Chemical***) Examination - 2013**

Process Instrumentation And Control (2008 Course)

[Time: *3* **Hours]** **[Max. Marks: 100]**

Instructions:

1 *Answer three questions from section-I and three questions from section-II.*

2 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*

3 *Neat diagrams must be drawn wherever necessary.*

4 *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*

5 *Assume suitable data, if necessary.*

SECTION -I

Q.1	A	Define Instrumentation and classify the instrument based on function.	8
	B	Explain with block diagram representation of a generalized measurement system.	8
		OR	
Q.2	A	Discuss the various process variables and give their classification in details.	8
	B	Differentiate between accuracy and precision.	8
Q. 3	A	Describe the operating principle, construction and working of thermocouple used for temperature measurement.	8
	B	Express pressure of 1.5 bar into units of i) MN/cm^2 ii) Pa iii) Psi iv) cm of Hg v) m of H_2O	8
		OR	
Q. 4	A	Describe the operating principle, construction and working of optical pyrometer.	8
	B	Explain with construction and working filled system thermometers.	8
Q. 5	A	Explain construction and working of Bubbler method and its application	9

	B	Describe with operating principles construction and working of orificemeter.	9
		OR	
Q. 6	A	Write a short note on i) Bob and Tape method. ii)Air Purge method.	9
	B	Explain classification of level measuring instruments.	9
		SECTION II	
Q. 7		Describe with neat diagram the following techniques of composition analysis. i) X-ray absorption spectroscopy. ii) Mass spectroscopy.	16
		OR	
Q. 8		Write short notes on i) PH meter ii) Liquid chromatography. iii)HPLC iv) Refractometry.	16
Q. 9	A	Describe Heat exchanger automatic control system with block diagram.	8
	B	Explain ON-OFF controller system with example.	8
		OR	
Q. 10	A	State differences between first order and second order system.	8
	B	Give classification of process variable with respect to process control.	8
Q. 11	A	With the help of block diagram explain working of feedback control system.	9
	B	Explain features of controller action. i) Auto/Manual Switch ii) Direct/ Reverse action	9
		OR	
Q. 12	A	Describe the control loop controlling level of liquid inside a surge vessel of manipulation of i) Input flowrate ii) Outlet flowrate	9
	B	State the differences between feedback and feed forward control system.	9

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T. E. (Chemical Engineering)

Chemical Engineering Thermodynamics II

(2008 COURSE)

]Total No. of Questions :12] [Total No. of Printed Pages: 8]

[Time : 3 Hours] [Max. Marks : 100]

Instructions :

(1) Answers to the two sections should be written in separate answer-books.

(2) Use if logarithmic table, electronics poket calculator is allowed

(3)Number to the right indicate full marks.

(4)Neat diagrams must be drawn wherever necessary.

(5)Use of logarithmic tables, slide rule, Molliercharts, electronic pocket calculator and steam tables is allowed.

(6) Assume suitable data, if necessary.

SECTION –I

Que1a) What is physical significance of chemical potential explain the effect of temperature and pressure on chemical potential (8)

b) The molar volumes of a binary solution at 25^o are measured as given below (8)

X_1	0	0.2	0.4	0.6	0.08	1.0
Vx10^6(m^3/mol)	20	21.5	24	27.4	32	40

Using the method of tangential intercept calculate the partial molar volumes of component 1 and 2 at

(i) $X_1 = 0.5$ (ii) $X_1 = 0.75$

OR

Que 2a) Show that the fugacity of gas obeying the van der waal's equation of state is given by (8)

$$\ln f = \frac{b}{V-b} - \frac{2q}{RTV} + ln\frac{RT}{V-b}$$

Where a and b are ven der waal's constant

b) If the partial molar volumes of species 1 in a binary liquid solution at constant temperature and pressure is given by

$\overline{V_1} = V_1 + \alpha\, x_2^2$

derive the equation for $\overline{V}_2$ what equation for V is consistence with this? (8)

Que 3a) Derive Gibbs – Duhem equation and discuss it's various forms (8)

b) The excess enthalpy of a solution is given by $H^E = x_1 x_2\,(40\, x_1 + 20\, x_2)$ (8)

J/mol determine expressions for $\overline{H}_1^E$ and $\overline{H}_2^E$ function of x_1.

OR

Que 4a) Explain property changes of mixing and derive equation for (8)

$\Delta G, \Delta H, \Delta V$, and ΔS

b) the excess Gibbs energy of a binary liquid mixture at T and P is given by: (8)

G^E / RT = (-2.6 x_1 -1.8 x_2) x_1 x_2 Find expression for $\ln\delta_1$ and $\ln\delta_2$ at T and P.

Que 5a) State Duhem's theorem and phase rule for non reacting system's (8)

b) A mixture a contain 45 % (mol) methanol (A) 30 % (mol) ethano l (B) and the rest is n propanol (C). Liquid solution may be may be assumed to be ideal and perfect gas law is valid for the vapor phase. Calculate at a total pressures of 101.3 KPa (10)

(i) the bubble point and the vapor composition

(ii) the dew point and the liquid composition the vapor pressure of the liquids are give below

Temp., K	333	343	353	363
P_A, KP_a	81.97	133.29	186.61	266.58
P_B, KP_a	49.32	73.31	106.63	166.61

P_C,KP_a	39.32	62.65	93.30	133.29
-	-	-	-	-

OR

Que 6a) Why does the boiling point diagram at a higher pleasure lie above that at lower pressure ? Discuss the effect if varying pressure on equilibrium diagram (8)

b) The vapour pressure of acetone acetonitrile and nitromethane can be represented by Antoine equation as (10)

$$\ln P_1^{sat} = 14.3916 - \frac{2795.82}{T+230}$$

$$\ln P_2^{sat} = 14.2724 - \frac{2945.47}{T+224}$$

$$\ln P_3^{sat} = 14.2043 - \frac{2972.64}{T+209}$$

Where P_1^{sat}, P_2^{sat} and P_3^{sat} are KP_a and T is in ^{0}C. Assuming that the system follow raovult's law calculate

(i) P and y_1 at T = 75^oC , $x_1 = 0.30$ $x_2 = 0.40$

(ii) P and x_1 at T = 80^oC , $y_1 = 0.45$, $y_2 = 0.35$

SECTION – II

Que 7a) Explain liquid – liquid equilibrium diagram for system in which two pairs are partially soluble. (8)

b.) The azoetrope of the ethanol – benzene system has a composition of 44.8% (mol) ethanol with a boiling point of 341.4 k at 101.3 KPa. At this temperature the vapor pressure of ethanol is 68.9 KPa and the vapor pressure of ethanol is 67.4 KPa . What are the activity coefficient in a solution containing 10% alcohol? (10)

OR

Que 8) Explain any tow method of consistency test for VLE data (10)

b) Derive various criteria for phase equilibrium (8)

Que 9a) Derive the following expression (8)

ΔG^0 = -RT ln k

b) n- Butane is isomerized to i-butane by the action of catalyst at moderate temperatures it is found that the equilibrium is attend at the following composition (8)

Temperature K	Mol % n- butane
317	31.00
391	43.00

Assuming that activities are equal to the mole function calculate the standard free energy of the reaction at 317 K and 391 K and average value heat reaction over this temperature range.

OR

Que 10a) in a chemical laboratory it is decide to carry out the reaction (8)

C_2H_5 OH (g) + ½ O_2 (g) → CH_3 CHO (g) + H_2O (g) at 1 bar and 298 K

Calculate standard gibb's free energy change at 298 K and predict whether it is feasible to carry out the given reaction or not. If possible, then calculate the equilibrium constant. we are given that

$\Delta G^o{}_{\text{f}\,CH_3\,\text{CH0}}$ = -133.978 KJ, $\Delta G^o{}_{\text{fCHO}}$ = -228.6 KJ, $\Delta G^o{}_{\text{fCh}_3\text{CHO}}$ = -174.883 KJ,

b). Determine the number of degree of freedom for each of the following system. (8)

i) A system of two miscible non reacting species which exists as an azoetrope in vapor / liquid equilibrium

ii) A system prepared by partially decomposing $CaCo_3$ in to an evacuated space

iii) A system prepared by partially decomposing NH_4 Cl into evaluated space.

iv) A System consisting of the gases CO, CO_2 H_2, H_2O and CH_4 in chemical equilibrium

Que 11a) Explain in brief application of equilibrium criteria to chemical reaction (8)

b) The following reaction take place in a system consisting of 3 mol CH_4, 1mol H_2O , 1mol CO and 4 mol H_2 initially :

$CH_4 + H_2O \rightarrow CO + 3H_2$

Express the composition of the mixture in terms of mole reaction as function of extent of reaction

OR

Que 12 a) Acetic acid is esterified in the liquid phase with ethanol at 100^0C and atmospheric pressure to produce ethyl acetate and water according to the reaction. (8)

$CH_3COOH(l) + C_2H_5OH\ (l) \rightarrow CH_3COOC_2H_5\ (l) + H_2O(l)$

If initially there is one mole each of ethyl acetic acid and ethanol , estimated the mole fraction of ethyl acetate in the reacting mixture at equilibrium .

Component	ΔH°_{f298}(J)	ΔG°_{f298}(J)
CH_3COOH	-484500	-389900
C_2H_5OH	-277690	-174 780
$CH_3COOC_2H_5$	-463250	-318280
H_2O	-285830	-237130

b) Derive the relationship between mole fraction of species in multiple reactions and the extent of reaction. (8)

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[4363]-213

T. E. (Chemical) Examination May 2013

INDUSTRIAL ORGANISATION AND MANAGEMENT

(2008 Pattern)(SEM I)

[Total No. of Questions:12] **[Total No. of Printed pages :2]**

[Time : 3 Hours] **[Max. Marks : 100]**

(1) *Answers any 3 questions from each section*

(2) *Answers to the two Sections should be written in separate answer-books*

(3) Figures to the right indicate full marks.

(4) Neat diagrams must be drawn wherever necessary.

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SECTION-I

Q.1 a) Explain in detail functions of Manager [8]

b) Explain in detail 'Sole Proprietorship' [8]

OR

Q.2 a) Define management. Explain different levels of management. Explain various functions of management. [10]

b) Enlist various organisation structure. Explain any two with a near sketch. [6]

Q.3 a) What are Trade Unions? Explain the role of trade unions in Industrial relations. [8]

b) What is meant by Manpower Planning? What are the objectives and benefits of Manpower Planning? [8]

OR

Q.4 a)Differentiate between M erit rating and job evaluation. State and explain various methods of merit rating. [16]

Q.5 a)What are the sore records? Explain bin card and store ledger accounts? [9]

b)Write notes on following selective control techniques [9]

i)A-B-C Policy

ii)V-E-D Analysis

iii)M-N-G Analysis

OR

Q.6 a)What are the different functions of store department? [9]

b)State various functions of purchase department [9]

SECTION-II

Q.7 a)Define Marketing research. What are objectives of marketing research? Explain various market research techniques [16]

OR

Q.8 a)Distinguish between Marketing and Selling [8]

b)Explain advertising along with its advantages. [8]

Q.9 a)Write an explanatory note on International trade [8]

b)What is anti-dumping duty? How it is levied? Explain the impact of anti-dumping duty in domestic business. [8]

OR

Q.10 a)Explain Patent. Write the procedure to file a patent in India. [8]

b)Explain in detail the export procedure following in India. [8]

Q.11 a)State and explain salient features of Contract Act. Explain various types of contracts. [9]

b)Differentiate between outline process chart and flow process chart. Explain various types of flow process chart with its characteristics. [9]

OR

Q.12 Write notes on (any three) [18]

a)FERA and FEMA

b)Therbligs

c)Work Study

d)MRTP

UNIVERSITY OF PUNE

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T. E. (Chemical) Examination - 2013

CHEMICAL PROCESS TECHNOLOGY

(2008 Pattern)

[Time : 3 Hours] **[Max. Marks : 100]**

Total No. of Questions : 12 **[Total No. of Printed Pages :2]**

Instructions :

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Neat diagrams must be drawn wherever necessary.

(4) Black figures to the right indicate full marks.

SECTION-I

Q.1

a) Describe production of aluminium. [08]

b) Discuss unit operations and unit processes with examples and applications. [10]

OR

Q2.

a) Describe production of soda ash. [10]

b) Discuss recovery of Mg salts from sea water [8]

Q3.

a) Discuss production of urea. [8]

b) Describe production of ammonium sulphate. [8]

OR

Q4.

a) Describe production of single super phosphate. [8]

b) Explain production of sulphuric acid. [8]

Q5.

a) Describe production of absolute alcohol. [8]

b) Explain production of paper. [8]

OR

Q6.

a) Discuss recovery of sucrose from sugarcane. [8]

b) Explain paper pulping process. [8]

SECTION-II

Q7.

a) Discuss production of detergents and their applications [10]

b) Explain construction and working of coke ovens. [6]

OR

Q8.

a) Describe production of natural glycerine. [8]

b) Explain solvent extraction of oil. [8]

Q9.

Draw neat diagram and explain in brief [16]

(1) Pyrolysis (2) Alkylation (3) Reforming (4) Polymerization

OR

Q10.

a) Explain manufacturing of : [16]

1) Natural gas 2) water gas 3) producer gas

Q11.

a) Discuss production of styrene. [12]

b) Describe methanol production process [6]

OR

Q12.

a) Explain production of Propylene. [6]

b) Discuss production of acetylene using steam cracking of hydrocarbons. [12]

UNIVERSITY OF PUNE

[4363]-216

T. E. (Chemical) May 2013 Examination

CHEMICAL REACTION ENGINEERING –I

(2008 Pattern)

[Total No. of Questions:12] **[Total No. Printed Pages:4]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

1) *Answer* ***any three*** *questions from each I and three questions from section II*
2) *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Black figures to the right indicate full marks.*
5) *Assume suitable data, if necessary.*

SECTION – I

Q.1 a) Explain classification of chemical reactions with suitable example [8]

b) Differentiate between molecularity and order of reaction. [4]

c) Differentiate between elementary and nonelementary reactions [4]

OR

Q.2 a) Explain temperature dependacy from Arrhenius Law of rate expression. [8]

What is Activation Energy E? How does it affects the temperature sensitivity of reaction?

b) For a first order reaction the following data is available. Estimate activation energy for the reaction. [8]

Temperature ^0C	310	330
$K(sec)^{-1}$	0.000886	0.0139

Assume R = 8.314 J/mol K

Q.3 a) What is meaning of Autocatalytic reaction? Draw and explain the X_A vs t and $-r_A$ vs C_A / C_{A0} curves for autocatalytic reactions. [4]

b) Derive integrated rate expression for first order reaction A → Product [6]
with variable volume system which is as follows.

$$-\ln (1- X_A) = -\ln \left(1 - \frac{\Delta V}{\varepsilon_A V_0}\right)$$

c) Explain in detail Integral method of analysis [6]

OR

Q.4 a) Show that the decomposition of N_2O_5 at a 70^0C is first order reaction, [10]
calculate the value or rate constant, reaction is $N_2O_5 \rightarrow N_2O_4 + {}^1/_2\, O_2$

b) At certain temperature, the half life period and initial concentration for [6]
a reaction are

$t\,{}^1/_2$ = 420 sec, C_{A0} = 0.405 mol/lit

$t\,{}^1/_2$ = 275 sec, C_{A0} = 0.64 mol/lit

Find the rate constant of reaction.

Q.5 a) Derive performance equation of Mixed Flow Reactor [9]

b) In train of CSTR of equal volume, an irreversible constant density first [9]
order reaction is carried out show that if number of CSTR is very large,
the total volume of all reactors in series tends to that of PFR for some
extent of conversion and show that

$$\tau_N = \frac{N}{K}\left[(C_0\text{-}C)^{1/N} - t\right]$$

$$\tau_P = \frac{1}{K} \ln (C_0 - C)$$

OR

Q.6 a) The liquid phase reaction A+ B ⟶ C + D take place in a CSTR of [9]
volume 25 m^3. The feed stream contains 5kmol/m^3 of A and 100mol/m^3
of B. What volumetric flow rate and space time is required to obtain 50%
conversion of the limiting reactant? The reaction rate constant is 0.0001

m^3/kmol.s at the reaction temperature.

b) Derive performance equation of Plug Flow Reactor [9]

SECTION – II

Q.7 a) Define instantaneous fractional yield and overall fraction yield Find out instantaneous fractional yield of reaction (Ψ) [6]

$$A + B \xrightarrow{K1} R \quad \frac{dC_R}{dt} = 1.0\ C_A^{1.2}\ C_B^{1.4}$$

$$A + B \xrightarrow{K2} S \quad \frac{dC_s}{dt} = 1.0\ C_A^{0.5}\ C_B^{2.0}$$

b) The desired liquid phase reaction [10]

$$A + B \rightarrow P + T \quad \frac{dC_P}{dt} = \frac{dC_T}{dt} = K_1\ C_A^{1.5}\ C_B^{0.4}$$

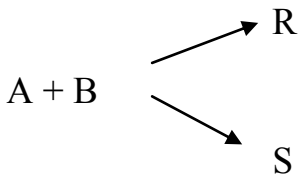
Is accompanied with undesirable side reaction.

$$A + B \rightarrow S + U \quad \frac{dC_u}{dt} = \frac{dC_s}{dt} = K_2\ C_A^{0.5}\ C_B^{1.8}$$

What contacting scheme (reactor type) would you use to carry above reaction to minimize concentration of undesired product?

OR

Q.8 8) Consider the following aqueous reaction [16]



$$\frac{dC_K}{dt} = 1.0\ C_A^{1.5}\ C_B^{0.3}$$

$$\frac{dC_s}{dt} = 1.0\ C_A^{0.5} C_B^{1.8}$$

For 90% conversion of A find the concentration of R in the product stream. Equal volumetric flow rates of the A and of B steam are fed to the reactor, and each stream has a concentration of 20mol/lit of reactant. The flow in the

reactor follow:

a) Plug flow
b) Mixed flow
c) Plug flow with low concentration of B when plug flow A with mixed flow B

Q.9 a) Explain effect of temperature, pressure and inerts on equilibrium conversions (X_{AC}) for exothermic and endothermic reactions. [6]
b) Explain optimum temperature progression for exothermic reversible reaction [6]
c) Draw and explain energy balance equation line for adiabatic operations [4]

OR

Q.10 a) For elementary liquid phase reaction [16]

$A \rightleftarrows R$

Make a plot of equilibrium conversion as a function of temperature. Determine the adiabatic equilibrium conversion as a function of temperature when pure A is fed to the reactor at 27^0C (300K)

ΔH^0_{fA} = -40000 cal/mol ΔH^0_{FR} = - 60000 cal/mol
C_{PA} = 50 cal/mol.K C_{PR} = 50 cal/mol.k
K = 1,00,000 at 298 k

Q.11 a) A sample of the tracer hytane at 320K was injected as a pulse to reactor and the effluent concentration measured as a function of time resulting in the following data [18]

t(min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C(g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

a) construct figures showing C(t) and E(t) as function of time
b) Determine fraction of material leaving the reactor that has spent between 3 and 6 min in the reactor
c) Determine fraction of material that has spent 3 min or less in the reactor

OR

Q.12 Write notes on (any three) [18]
a) C and E,F curves
b) Dispersion model
c) Examples of non ideality in reactors
d) Tank in series model.

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T. E. (Chemical) Examination - 2013

TRANSPORT PHENOMENA

(2008 Pattern)

[Time : 3 Hours] **[Max. Marks : 100]**

Total No. of Questions : 12 **[Total No. of Printed Pages :5]**

Instructions :

*(1) Answers to the **two sections** should be written in **separate answer-books***

(2) Neat diagrams must be drawn wherever necessary.

(3) Black figures to the right indicate full marks.

(4) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(5) Assume suitable data, if necessary.

SECTION I

Q1) a) Explain time independent fluids and time dependent fluids. [6]

b) Compute the mean molecular velocity $\bar{u}$, and mean free path λ of O_2 [6]

at 1 atm and 273.2 ^{0}K. Assume d = 3 A^0 what is the ratio of the mean free path to the molecular diameter in the situation.

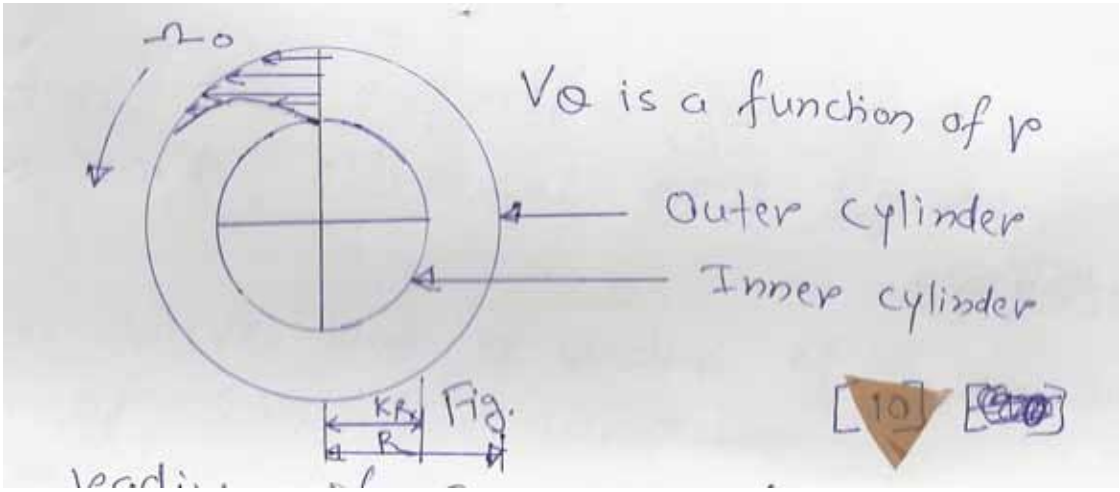
c) An horizontal annulus is 27 ft long. The outside radius of inner cylinder is 0.495 inch. The inside radius of outside cylinder is 1.1 inch. The fluid density is 80.3 lb/ft^3 and viscosity is 136.8 lb m/ft. S. What is the volume rate of flow, the impressed pressure drop is 5.39 Psi. [6]

OR

Q2) a) Derive the expression for ratio of average velocity to maximum velocity [18]

For a Newtonian fluid flow through a circular tube.

Q3) a) Determine the velocity and shear stress distribution for tangential laminar flow of an incompressible fluid between two vertical co-axial cylinders, the outer of which is rotating with angular velocity Ω_0 (refer Fig.) , Also write assumptions. [10]



b) Find the radius of capillary from following data: [6]

Length of capillary = 50.02 cm

Kinematic viscosity of fluid = 4.03×10^{-5} m^2 sec^{-1}

Density of fluid = 0.9552×10^3 Kg/m^3

Pressure drop across (horizontal capillary) tube = 4.766 atm

Mass rate of flow through tube = 2.997×10^{-3} Kg/sec.

OR

Q4) a) Explain friction factor and friction losses in pipe fittings, sudden expansion and contraction. [8]

b) Water enters a boiler at 18.33 ^{0}C and 137.9 KPa through a pipe at an average velocity of 1.52 m/s. Exit stream at a height of 15.2 m above the liquid inlet leaves at 137.9 KPa, 148.9 ^{0}C and 9.14 m/s in the outlet line. At steady, how [8]

much heat must be added per kg mass of stream. The flow in two pipes is turbulent.

Q5) a) Deduce the expression for heat conduction with electrical heat source. [10]

b) A copper wire has a radius of 2 mm and a length of 5m. for what voltage drop would the temperature rise at the wire axis be 10 ^{0}C, if the surface temperature of the wire is 20 ^{0}C. [6]

OR

Q6) a) An oil is acting as a lubricant for a pair of cylindrical surface. The angular velocity of the outer cylinder is 7908 rpm. The outer cylinder has a radius of 5.08 cm and the cleavence between the cylinder is 0.027 cm. What is the maximum temperature in the oil if both wall temperature are known to be 70 ^{0}C . Assume cylindrical surface as of concentric type [16]

The physical properties of oil are ,

Viscosity 92.0 Cp

Density 1.22 gm cm^{-3}

Thermal conductivity 0.0055 Cal sec^{-1} ^{0}C^{-1} .

SECTION II

Q7) a) Derive the expression for heat flux of the composite cylinder of radii r_1 and r_2 respectively. [10]

b) Explain heat transfer coefficients for forced convection around subnormal object. [8]

OR

Q8) a) Discuss in brief heat transfer coefficients for forced convection through packed beds. [6]

b) State and explain comparison of forced and free convection in nonisothermal [6]

systems.

c) Air at 70 ^{0}F and 1 atm is to be pumped through a straight 2 inch I. D. tube at a rate of 70 lbm/hr. A section of the tube is to be heated to an inside wall temperature of 250^{0}F to raise the air temperature to 230 ^{0}F. What heated length is required. [6]

Q9) a) Derive equation of molar flux for diffusion with heterogeneous chemical reaction. [8]

b) The solute HCL(A) is diffusing through a thin film of water (B) 2 mm thick at 283 ^{0}K. The concentration of HCL at point (i) at one boundary of the film is 12 wt % HCL (density ρ_1 = 1061 Kg/m^3) and other boundry at point (2) it is 6 wt % HCL (ρ_2 = 1030 Kg/m^3). The diffusion coefficient of HCL in water is 2.5 x 10^{-9} m^2/s. [8]

Assuming steady state conditions prevail and the boundry is impermeable to water Calculate the flux of HCL in K mole/m^{2}sec.

OR

Q10) a) Show that : [16]

$$N_{AZ|Z=Z1} = \frac{CD_{AB}}{(Z_2 - Z_1)_{x_{Bln}}} (x_{A1} - x_{A2})$$

If the rate of mass transfer is related to a characteristic concentration driving force $X_{A1} - X_{A2}$ for diffusion through a stagnant gas film.

Q11) a) A shallow bed of water saturated granular solids is to be dried by boiling dry air air through it at 1.1 atm pressure and a superficial velocity of 15ft/s. what air temperature is required initially to keep the solids at a surface temperature of 60 ^{0}F. [8]

b) Explain concentration profile at the gas – liquid interface by considering [8]

analogous situation for mass transfer (NO wall resistance).

OR

Q12) a) Write analogies among heat, mass and momentum transfer. [8]

b) write note on macroscopic and microscopic balance. [8]

[Total No. of Questions: *12*] **[Total No. of Printed Pages:** *6*]

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T. E. (Chemical) Examination - 2013

CHEMICAL ENGINEERING DESIGN-I (2008 Course)

[Time: *3* **Hours]** **[Max. Marks: 100]**

Instructions:

1 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*

2 *Black figures to the right indicate full marks.*

3 *Your answer will be valued as a whole*

4 *Neat diagrams must be drawn wherever necessary.*

5 *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*

6 *Assume suitable data, if necessary.*

SECTION -I

Q.1	A	Write on plastics as material & construction for chemical plants	6
	B	Describe any two :	10
		i) Radio graphy test	
		ii) Freon test	
		iii) Dye penetration test	

OR

Q.2	A	Discuss various factors to be considered for selection of materials of constriction for handling corrosive fluids.	8
	B	What is optimization ? Discuss in detail optimization techniques	8
Q. 3	A	With neat sketch explain Reinforce ment of nozzles	8
	B	Explain the selection of heads for pressure vessels. with neat sketches explain the constructional features of different types of head and give their design equations	10

OR

Q. 4	A	Calculate the thickness of torspherical head (100-6), (80-10) and elliptical head (2:1) for a vessel having a design pressure of 3.5 Hg/ cm^2. weld joint efficiency is 100% . Also calculate the percentage reduction in thickness of toristrispherical head (100-6). Permissible stress for material of construction is 1250 kg/cm^2	9
	B	Design the flange for stainless steel shell having inner diameter 1200mm. The flange is made of carbon steel. A flat asbestos gaslat of 1200 mm internal diameter and 1240 mm external diameter of 3mm thickness is used to cover the raised level of flange. Internal pressure = 3 kg /cm^2 Gaslat factor (M) = 2.0 Minimum design seating stress (y_a) = 112 kg/cm^2 f a= 587 kg / cm^2	9

f b = 545 kg/ cm^2

For M18 bolts,

Pitch diameter = 16.37mm

Minor diameter = 14.480 mm

Pitch circle diameter = 1310 mm.

Allowable stress for flang material = 952 kg/cm^2

Q. 5	A	Write a note on stresses in cone roof	6
	B	A strong tank is to store 24000 kg of liquid having density 900kg/m^3. Due to space limitations the maximum tank diameter can be 2.4 m. calculate the height of the tank. Liquid is to be filled up to roof shell Junction . No corrosion allowance is necessary. Weld Joint efficiency is 85% and permissible stress of material is 1020 kg / cm^2	6
	C	Explain shrink fit constriction for high pressure vessels	4

OR

Q. 6	A	Explain various types of losses density storage of volatile liquids	6
	B	Explain various types of roofs used for storage vessels	6
	C	Explain hortonspheres as storage vessels	4

SECTION II

Q. 7	A	Skirt support is to be designed for tall vertical ; vessel having diameter 2.5 m and height 39m. skirt diameter is equal to the diameter of the vessel while the skirt height is 4.m. The weight of the vessel with all its attachments is 2,00,000 kg. The minimum weight of he vessel is 1,50,000 kg. the wind pressure acting over the	16

vessel is 130 kg/m^2. seismic coefficient = 0.08, k for cylindrical vessel = 0.70.

Permissible tensile stress of material = 1400 kg/cm^2 yield stress of the material = 2000 kg / cm^2, Permissible stress for concrete = 45 kg/cm^2. Bolt circle diameter is 32 cm greater than the skirt diameter, No of bolts to be used is 20

OR

Q. 8	A	Explain the design of saddle support with all the equations involved	10
	B	With neat sketch explain bracket support and Leg support	6
Q. 9	A	1800 kg/hr of an organic liquid is to be cooled from 100^o C to 60^o C by water available at 15^oC. The maximum temperature to which water can be heated is 42^oC. Water is circulated through the annulus of concentric tube heat exchanger. ID of inner tube = 12.5 mm. OD of inner tube = 14.5 mm ID of outer tube = 22 mm. Design the heat exchanger. Neglect fonling and tube wall resistance. Properties of organic liquid – Density = 1078 kg/m^3 viscosity = 3.2 m N s/m^3, specific heat = 2650 J/kg. k, Thermal conductivity = 0.26 w/m.k Water – Density = 995 kg/m^3 viscosity = 0.853×10^{-3} N.s/m^2 sp. heat = 4180 J/kg k, Thermal conductivity = 0.61 W/m.k	18

OR

Q. 10	A	A horizontal water heater is required to heat 15000 kg/hr of water from 15°C to 85°C by means of steam considering at 110°C. The heater is to consist of tubes having 1.9 cm OD and 1.65 cm ID. Determine the number of tubes required and the length of each tube if the velocity of water inside the tube is not to exceed 0.75 m/sec. Latent heat of. Steam at 110°C is 533 kcal/ kg. Properties of water are as follows. μ = 1.88 kg/m.hr, Cp = 1.00 kcal/ kg °C, ρ = 985 kg/m^3 k = 0.37 kcal/hr.m.°C, Assume countercurrent How Metal wall resistance can be neglected. Dirt coefficient = 0.0006	12
	B	Discuss the need of using tube correction factor in heat exchanger design and explain how it is calculated?	6
Q. 11	A	A single effect evaporator is to be designed to concentrate 10,000 kg/hr of a chemical solution from 10% to 20% solids by weight feed enters at 30°C saturated steam at 110°C (latent heat 540 kcal/kg) is available. Condensate leaves at saturation temperature. The solution boils at 45°C (latent heat – 570 kcal/kg). specific heats of all solutions may be taken as 1.0 kcal/kg °C overall heat transfer coefficient may be taken as 1800 kcal / hr m^2 °C. calculate i) Steam consumption (kg/hr) ii) Heat transfer area.	12
	B	For a forward feed triple effect evaporation system	4

write the energy balance equations

OR

Q. 12	A	Explain the design methods for mixed vapour condensers and how the true temperature difference is evaluated in such cases?	8
	B	In case of reboilers how the heat transfer coefficient is calculated for Pool boiling. Explain all the equations involved in the calculations.	8

[Total No. of Questions: *12*] **[Total No. of Printed Pages:** *5*]

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T. E. (Chemical) Examination - 2013
Mass Transfer-II (2008 Course)
[Time: *3* **Hours]** **[Max. Marks: 100]**

Instructions:

1 ***Answer 3 questions from Section I and 3 questions from Section II.***
2 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*
3 *Black figures to the right indicate full marks.*
4 *Neat diagrams must be drawn wherever necessary.*
5 *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6 *Assume suitable data, if necessary.*

SECTION -I

Q.1 A A liquid mixture containing 40 wt % benzene and 60 wt % tolune is subjected to flash distillation at pressure 101.325 Kpa.If the fraction of feed vaporized is 0.50,calculate the equilibrium composition of vapour and liquid. 8

X	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Y	0.13	0.21	0.375	0.5	0.6	0.7	0.77	0.83	0.9	0.95	1.0

B What is distillation? Define differential distillation and derive Rayleigh equation. 8

OR

Q.2 A Explain in brief (a)Steam distillation (b)Optimum reflux ratio 8

B A liquid mixture containing 50-mole% n-heptane and 50 –mole % n-octane is subjected to differential distillation at atmospheric pressure until the residual liquid contain 35 mole % n-heptane.Find out the percentage of feed left over as residue. 8

X	0.5	0.46	0.42	0.38	0.34	0.32
Y	0.689	0.648	0.608	0.567	0.523	0.49

Where x-mole fraction of n-heptane in liquid & y-mole fraction of n-heptane in vapor.

Q. 3 A 10 kmol/hr of mixture containing 42 mole percent heptanes and 58 mole percent ethyle benzene is to be fractioned to a distillate containing 97 mole percent 16

heptanes and residue containing 99 mole percent ethyl benzene using a total condenser and feed at its
Saturated liquid condition. The enthalpy concentration data for the heptane-ethyl benzene at 1 atm pressure as follows.

X heptane	0	0.08	0.18	0.25	0.49	0.65	0.79	0.91	1.0
Y heptane	0	0.28	0.43	0.51	0.73	0.83	0.90	0.96	1.0

H_1 (kJ/kmol) $\times 10^3$	24.3	24.1	23.2	22.8	22.05	21.75	21.7	21.6	21.4
H_0(kJ/kmol) $\times 10^3$	61.2	59.6	58.5	58.1	56.5	55.2	54.4	53.8	53.3

Using Ponchon Savarit method Calculate the following.
1.Minimum reflux ratio
2.Number of stages at reflux of 2.5
3.Condenser duty
4.Reboiler duty

OR

Q. 4 A Is to be designed for separating 10000 kg per hour of a liquid mixture containing 40 mole % methanol and 60 mole % water is to be separated in a continuous fractionating column in to an overhead product containing 97 mole% methanol and bottom product having 98 % mole water.A mole reflux ratio of 3 is used.Calculate (i)moles of overhead product obtained perhour,(ii)number of ideal plates and location of feed if the feed is at its bubble point.Equilibruim data — 10

X	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0.417	0.579	0.669	0.729	0.78	0.825	0.871	0.915	0.952	1.0

B What are the drawbacks of Mc-Cabe Thiele method?Derive equation of q-line. — 6

Q. 5 A Give the classification of liquid –liquid extraction equipments. — 4

B Acetone is to be recovered from an aqueous solution containing 20 % by weight of acetone using kerosene as solvent.The equilibrium distribution of acetone in water and kerosene as solvent.The equilibrium distribution of acetone in water and kerosene follows the relationship X=6.45Y,where Y=kg acetone /Kg kerosene and X= kg acetone/kg water.If the extraction is done in three equilibrium stages using 5 kg of solvent in each case,find the concentration of final raffinate.If the same final concentration is to be — 10

obtained in single stage determine the amount of solvent required.

C Explain use of triangular diagram in liquid liquid extraction. 4

OR

Q. 6 A 1000 kg of pyridine –water solution containing 59 % pyridine is to be extracted with equal amount of pure chlorobenzene.The raffinate from the first extraction is to be extracted with a weight of solvent equal to raffinate weight and so on(S2=R1,S3=R2). 16

(a)What is the exit concentration and percentage recovery of pyridine after three stages.(b)if all the solvent is used in single stage what is the percentage recovery and exit concentration.The equilibrium data and tie line data is as given below.

Chlorobenzene Layer(C.B.)			Water Layer		
Pyridine	C.B	Water	Pyridine	C.B.	Water
0.0	99.95	0.05	0	0.08	99.92
11.05	88.28	0.67	5.02	0.16	94.82
18.95	79.90	1.15	11.05	0.24	88.71
24.10	74.28	1.62	18.90	0.38	80.72
28.60	69.15	2.25	25.50	0.58	73.92
31.55	65.58	2.87	36.10	1.85	62.05
35.05	61.00	3.95	44.95	4.18	50.81
40.60	53.00	6.40	53.20	8.50	37.90
49.00	37.8	13.2	49.00	37.8	13.20

B Give advantages of liquid liquid extraction over distillation. 2

SECTION II

Q. 7 A 350 kg per hour of halibut liver is to be extracted in a counter current cascade with ether to recover oil.The ether which has been partially purified contains 2% oil.The fresh liver contains 20 % oil and are to be extracted to a composition 10 % oil (on solvent free basis)250 kg of solvent is to be used. 12

(i)What % of oil entering with the liver recovered in the extract?

(ii)How many equilibrium stages are required?

Data:

Kgoil/kg solution	0	0.1	0.2	0.3	0.4	0.5	0.6
Kgsolution/kg exhausted liver	0.288	0.368	0.44	0.51	0.6	0.71	0.87

B List the commercial leaching processes. 6

OR

Q. 8 A Roasted copper ore containing as CuSO4, is to be extracted in a counter current extractor.The feed charge to be treated per hour comprises of 10 12

tones of gangue,1.2 tones of copper sulphate and 0.5 tone of water.The strong solution produced is to consist of 90 % H_2O and 10% $CuSO_4$ is to be 98% of that of ore.Pure water is to be used as the fresh solvent.After each stage one tone of water plus copper sulphate dissolved in that water.Equilibrium is attained in each stage.How many stages are required?

B Discuss the methods of operation of liquid-solid contacting in leaching. 6

Q. 9 A The equilibrium water absorbed by a silica gel in contact with moist air varies linearly with humidity of air. 12

Y=0.034435X

Where , X=kg water absorbed /kg of dry gel.

Y=humidity of air,kg moisture/kg dry air

0.5 kg of silica gel containing 5 % (dry basis)absorbed water is placed in a collapsible vessel in which there are 10 m^3 of moist air,the partial pressure of water is 15 mm Hg.The total pressure and temperature are kept at 1 atm and 298 K respectively.What is the amount of water picked up from the moist air in the vessel by silica gel?Also calculate the final partial pressure of the water vapors in the vessels and final total pressure in the vessel.

B Write principles of ion exchange process. 4

OR

Q.10 A A solution of washed raw cane sugar is colored by the pressure of small amounts of impurities.The solution is to be decolorized by treatment with an adsorptive carbon in a contact filtration plant.The original solution has a color concentration of 9.6 measured on an arbitrary scale and it is desired to reduce color of 0.96 .calculate the necessary dosage of the fresh carbon per 2000 kg solution for a single stage process.The data for an equilibrium isotherm is as follows. 12

Kg carbon/kg solution	0	0.001	0.004	0.008	0.02	0.04
Equilibrium color	9.6	8.6	6.3	4.3	1.7	0.7

B What is adsorption hysteresis. 4

Q.11 A A solution contains 500Kg Na_2Co_3 and water has a concentration of 25% by wt of salt.It is cooled from 335 K to 285 K in an agitated mild steel vessel.Wt.of the vessel is 750 Kg.2.0 % water is lost by evaporation crystals of Na_2CO_3 10 H_2O are formed.Calculate the yield of crystals and the heat to be removed? 12

Data:

Solubility At 285 K:8.9 Kg/100 Kg water.
Heat capacity of solution:3.6 KJ/Kg K.
Heat capacity of M.S. : 0.5 KJ/KgK.
Heat of solution:78.5 MJ/KMol
Latent heat of Vaporization:2395 KJ/Kg.

B Give flux equation for a pressure driven process. 4

OR

Q. 12 A Calculate the yield of $MgSO_4.7H_2O$ crystals when 1000 kg saturated solution of MgSO4 at 353 K is cooled to 303 K.Assuming 10 % of the water is lost by evaporation during cooling. 12

Data:
Solubility of $MgSO_4$ at 353 K= 64.2 Kg/100 Kg water.
Solubility of $MgSO_4$ at 303 K= 40.8 Kg/100 Kg water.
Atomic Wt.Mg:24, S:32 , O=:16, H:1

B Explain Ultra filtration along with application. 4