Time: 3hour   **Marks: 80**

N.B. (1) Question No 1 is compulsory
(2) Attempt any three questions out of remaining five questions
(3) Assumption made, if any should be clearly stated

Q.1	**Solve any Four**	**20**
a)	Give the difference between Ideal and Non Ideal solution	
b)	State Raoult's law. Show that it is simplified form of Lewis Randall Rule	
c)	Explain Effect of Temperature on Chemical Potential	
d)	Explain Refrigerator capacity	
e)	A refrigeration machine operating at a condenser temperature of 290 K needs 1 kW of power per ton of refrigeration. Determine the following:	

 i)The coefficient of performance
 ii)The heat rejected to the condenser
iii)The lowest temperature that can be maintained

Q.2a) Define   **10**
i)Equilibrium constant
ii) Extent of reaction or reaction coordinate.

b) A mixture of 1 mole of CO and 1 mole of water vapour is undergoing the water- gas shift   **10**
reaction at a temperature of 1100 K and a pressure of 1 bar.

$$CO (g) +H_2O (g) \rightarrow CO_2 (g)+H_2 (g)$$

The equilibrium constant for the reaction is K=1.Assume that the gas mixture behaves as ideal gas. Calculate
a) The fractional dissociation of steam
b) The fractional dissociation of steam if the reactant stream is diluted with 2 mol nitrogen.

Q.3a) Explain VLE in ideal and non-ideal solutions.   **10**
b) Define Refrigeration. Discuss Vapour compression refrigeration cycle   **10**

Q.4a) Define excess property and Property change of Mixing and show that the property change   **10**
of mixing and excess properties are identical.
b) Derive various forms of Gibbs-Duhem equation   **10**

Q.5a) Explain different methods of determination of partial molar properties   **10**
b) Derive Van't Hoff Equation   **10**

Q.6a) The vapour pressures of aceton(1) and acetonitrile(2) can be evaluated by the Antoine   **10**
equations.
$\ln p_1^s = 14.5463 - \frac{2940.46}{T-35.93}$
$\ln p_2^s = 14.2724 - \frac{2945.47}{T-49.15}$
where T is in K and P is in kPa. Assuming that the solution formed by these are ideal, calculate
a) x_1 and y_1 at 327 K and 65 kPa
b) T and y_1 at 65 kPa and $x_1 = 0.4$
c) P and y_1 at 327 K and $x_1 = 0.4$

b) Explain Boiling point diagram (T-x-y plot) and equilibrium diagram (x-y plot) for binary   **10**
solution

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(3 Hours) [Total Marks: 80]

N.B. : 1) Question No. **1** is **Compulsory**.
2) Answer **any THREE** questions from Q.2 to Q.6.
3) Figures to the right indicate full marks.

Q.1 **(a)** Fit a straight line to the following data (5)

X	1	2	3	4	5	6
Y	49	54	60	73	80	86

(b) Calculate Correlation coefficient between the variables x and y for the following (5)
data

X	12	15	18	21	27
Y	2	4	6	8	12

(c) Let X be a continuous random variable with probability density function (5)
$f(x) = \frac{x}{6} + k, \ 0 \le x \le 3$ Find k and $(1 \le x \le 2)$.

(d) Find the line integral of $\bar{F} = x^2 i + xy j$ along line OP where, (5)
$O = (0,0) \ and \ P = (1,1)$.

Q.2 **(a)** A random variable x has the following probability function (6)

X	-2	-1	0	1	2	3
P(x)	0.1	k	0.2	2k	0.3	3k

Find i) k ii) P(x > 2) iii) E(X)

(b) Prove that $\bar{F} = (x + 2y + az)i + (bx - 3y - z)j + (4x + cy + 2z)k$ is (6)
solenoidal and find the constants a,b,c if $\bar{F}$ is irrotational.

(c) Evaluate $\int_c \frac{z+6}{z^2-4} dz$ where c is (i) $|z| = 1$ (ii) $|z - 2| = 1$ (iii) $|z + 2| = 1$. (8)

Q.3 **(a)** The average breaking strength of steel rods is specified to be 17.5 (in units of (6)
1000 kg) to test this sample of 14 rods tested & gave the following results: 15,
18, 16, 21, 19, 21, 17, 17, 15, 17, 20, 19, 17, 18. Is the result of the experiment
significant?

(b) Use Green's theorem to evaluate $\int_c (2x^2 - y^2) dx + (x^2 + y^2) dy$ where c is (6)
the boundary of the region enclosed by the lines $x = 0, y = 0, x = 2, y = 2$.

(c) If height of 500 students are normally distributed with mean 68 inches and (8)
standard deviation 4 inches, Find the number of students having heights (i)
greater than 72 inches (ii) between 65 and 71 inches (iii) less than 62 inches.

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Q.4 **(a)** Use Gauss Divergence theorem to evaluate $\iint_s \bar{F}.\hat{n}\,ds$ where **(6)**
$\bar{F} = 4xz\hat{i} - y^2\hat{j} + yz\hat{k}$ and s is the surface of the cube bounded by
$x = 0,\ x = 1,\ y = 0,\ y = 1, z = 0, z = 1.$

(b) Find the lines of regression for the following data to estimate y **(6)**
corresponding to $x = 155$

X	100	110	120	130	140	150	160	170	180	190
Y	45	51	54	61	66	70	74	78	85	89

(c) Find all possible Laurent's series expansion of the function $f(z) =$ **(8)**
$\frac{5z+7}{(z+3)(z+2)}$ about $z = 0$ indicating region of convergence.

Q.5 **(a)** The standard deviation from two random samples of sizes 9 and 13 are 1.99 **(6)**
and 1.9. Can the samples be regard as drawn from normal population with
same standard deviation? $(F_{(8,12)}(0.025) = 3.51, F_{(12,8)}(0.025) = 4.20)$

(b) Using Stoke's Theorem to evaluate $\int_c \bar{F}.d\bar{r}$ where $\bar{F} = yi + zj + xk$ **(6)**
and c is the boundary of surface $x^2 + y^2 = 1 - z,\ z > 0.$

(c) In an experiment on immunization of cattle from tuberculosis the following **(8)**
results were obtained (use 5% LOS)

	Affected	Not Affected	Total
Inoculated	267	27	294
Not Inoculated	757	155	912
Total	1024	182	1206

Use Chi Square test to determine the efficiency of vaccine in preventing
tuberculosis.

Q.6 **(a)** A bag contains 7 red balls and 3 black balls and another bag contains 4 red **(6)**
balls and 5 black balls. One ball is transferred from the first bag to the
second bag then a ball is drawn from the second bag. If this ball happens to
be red, Use Bayes' theorem to find the probability that a black ball was
transferred.

(b) A car hire firm has 2 cars which it hires out day by day. The number of **(6)**
demands for a car on each day is distributed as Poisson variate with mean
1.5. Calculate the probability of days on which some demand is refused.

(c) Show that $\bar{F} = (2xy + z)i + (x^2 + 2yz^3)j + (3y^2z^2 + x)k$ is **(8)**
conservative. Find scalar potential such that $\bar{F} = \nabla\emptyset$ and hence, find the
work done by $\bar{F}$ in displacing a particle from (1,2,0) to (2,2,1).

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Time: 3 hours   Max. Marks: 80

N.B: 1. **Question.No.1 is compulsory.**
        2. **Attempt any three questions from Q.No.2 to Q.No.6**
        3. **Assume suitable data.**
        4. **Figures to the right indicate full marks**

Q1   Solve any Four out of Six (5 Marks each)   (20 Marks)

A   Define electrophoresis. Explain its applications.

B   Write short notes on catalytic poisoning.

C   Describe the principle and applications of IR spectroscopy.

D   Explain the concept of aromaticity in Furan

E   What are the advantages and disadvantages of using liquid ammonia as a solvent?

F   Write a short note on Thin Layer Chromatography (TLC).

Q2   (20 Marks)

A   Describe the principle of UV-Vis spectroscopy.

B   Explain Paper chromatography in detail.

C   Explain the dielectric constant of ionising solvents and its significance..

D   Describe the mechanism of the Beckmann rearrangement reaction with an
            example.

Q3   (20 Marks)

A   What is auto catalysis? Give an example.

B   Explain the shielding and deshielding effects in NMR spectroscopy.

C   What are emulsifying agents? Describe their role in emulsion formation.

D   Explain the concept of aromaticity in Naphthalene.

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Q4 (20 Marks)

A Give a note on Donnan membrane equilibrium & its significance.

B Explain the working and application of Gas Chromatography-Mass Spectrometry (GC-MS).

C Explain Reformatasky Reaction with mechanism.

D Explain the role of non-aqueous solvents in precipitation reactions.

Q5 (20 Marks)

A Explain concept of electrical double layer with Helmholtz & Stern model.

B Write one preparation & two applications of acetoacetic ester.

C Explain the importance of NMR spectroscopy in organic chemistry

D Explain the working and application of High-Performance Liquid Chromatography (HPLC).

Q6 (20 Marks)

A What are aprotic and protic solvents? Explain their significance

B Describe in detail the working and applications of Differential Thermal Analysis (DTA).

C What are colloids? Give its importance in Foods.

D What are catalytic promoters and inhibitors? Explain with examples.

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19/05/2025 SE CHEMICAL SEM-IV C-SCHEME NMCE QP CODE: 10082531

Time: 3 Hours   **Total Marks: 80**

N.B.:
(i) Question No.1. Is compulsory.
(ii) Attempt any three questions out of remaining five questions.
(iii) Assume suitable data and justify the same.

Q 1		Solve any Four.	20

(a) Solve the following partial differential equation by using Bender Schmidt method.

$u_{xx}= u_t$ subject to u(0,t)=0, u(5,t) = 0, u(x,0)=$x^2(25-x^2)$ taking h=1, up to 3 seconds.

(b) Define Accuracy and Precision

(c) Find an iterative formula to find $\sqrt{N}$ and hence find the value of $\sqrt{5}$

(d) Explain the procedure for finding the root using a bisection method.

(e) Solve by using least square straight line method.

X	1	2	3	4	6	8
Y	2.4	3	3.6	4	5	6

Q 2 (a) Calculate the volume of superheated steam at 100 atm and 350^0C using equation   12

$(P + \frac{a}{V^2})$ (V-b) = RT

Use Newton Raphson method to find the volume and for initial values of V, use ideal gas

equations, where a= $\frac{27R^2T_c^2}{64P_c}$, b = $\frac{RT_c}{8P_c}$, T_c = 647.11K, P_c = 220.76 atm,

R=8.206$\times 10^{-5}$ atm/molK.

(b) Find the root of an equation f(x)= x^3-x-1 = 0 using secant method.   8

Q3 (a) Find the solution of $2x^3$- 4x+1 = 0 using   10

1. Trapezoidal Rule
2. Simpson's 1/3 rd rule
3. Simpson's 3/8th rule

(b) Solve by Gauss Elimination method: 10

3x+4y+5z = 18

2x-y+8z = 13

5x-2y+7z = 20

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Q4 (a) Using Runge kutta fourth order method, find y(0.8) correct to 4 decimal places   10
if $\frac{dy}{dx}$ = y-x², y(0.6) = 1.7379

  (b) Using modified Euler's method solve the equation $\frac{dy}{dx}$ = 1- y, y(0) = 0, tabulate the   10
solution at x = 0.1, 0.2, 0.3

Q5 (a) Solve by Crank Nicholson method the equation $u_{xx} = u_t$ subject to the condition   10
u(x,0) = 0, u(0,t)=0, u(1,t) = t. taking h= 0.25 for one time steps. -

  (b) A dynamic model spherical tank, $\frac{dh}{dt} = \frac{f_0 - f}{\frac{\pi}{4}D^2}$ where, D is a diameter of tank, f_0 is the inlet   10

flowrate, f is the outlet flowrate and h is level in the tank. If tank dimension are given ,

find the liquid level in tank with respect to time. Take step size of 5 sec show calculations

till 20 sec. use Improved Euler's method.

Given:- Diameter of tank = 1m,

Height of the tank = 2m

F = 0.04 $\sqrt{h}$ in m³/s.

F₀ = 0.06 m³/s.

t = 0 sec, h = 1m

Q6) a) Evaluate the function u(x,y) satisfying $\nabla^2 u = 0$ at lattice points given by the boundary value.   12
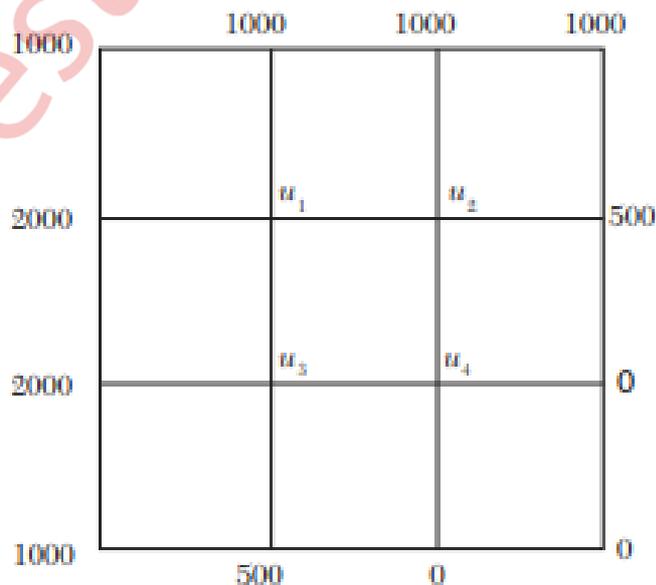
b)   A process stream containing 100 kg of a mixture of three chemical (A, B, C) is treated by   8
two separators. In the first separator (P), most of A is removed and in the second separator
(Q), most of the B is removed. The final outlet (R) contains a C- rich stream. The
compositions of the three outlet streams are shown in fig below. Solve it by Gauss
Elimination to find P, Q, R.

P (A = 80%,
B= 10%, C =
10%)

Q (A = 2%,
B= 83%, C =
15%)

F

F (A = 50%,
B= 30%, C =
20%)

R (A = 6%,
B= 12%, C =
82%)

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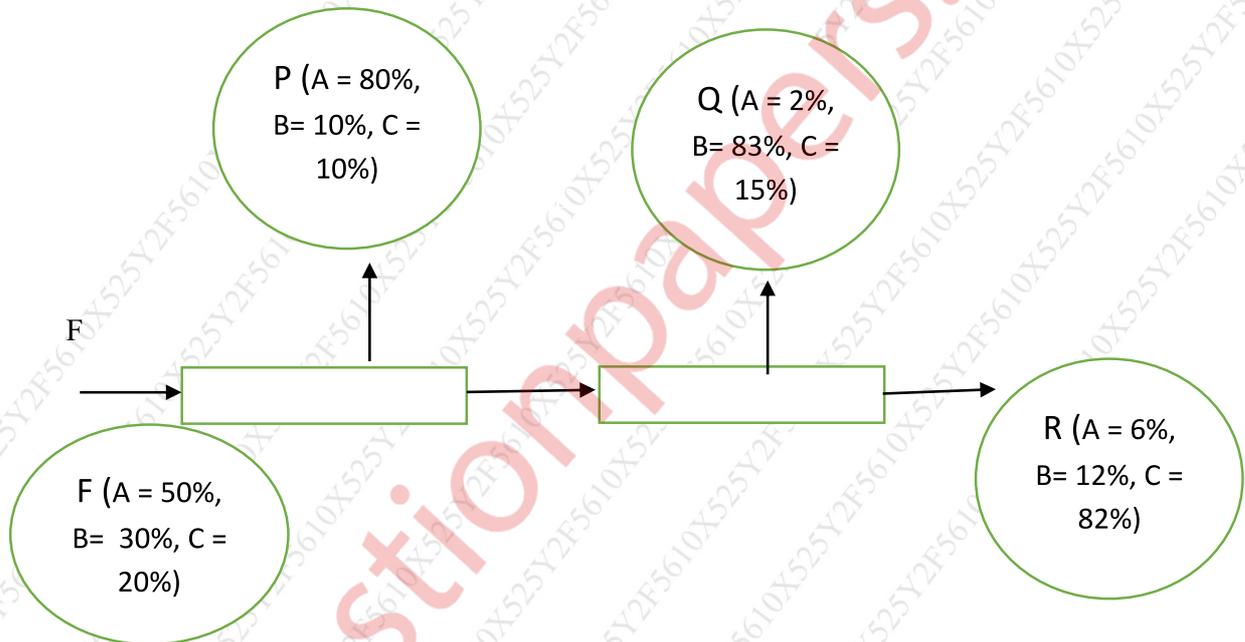
21/05/2025 SE CHEMICAL SEM-IV C-SCHEME SFMO QP CODE: 10083221

Time: 3 Hours   **Total Marks: 80**

N.B.   (i) Question number 1 is compulsory.
            (ii) Answer any three questions from rest.
            (iii) Assume suitable data wherever necessary.

Q. 1   (A)   Explain Sphericity with its significance   [05]
        (B)   Write assumptions for Kynch theory of sedimentation.   [05]
        (C)   Explain Negative pressure pneumatic conveying system.   [05]
        (D)   A soil containing 14% moisture was mixed in large muller mixer with 10   [05]
              weight percent of a tracer considering of dextrose and pictric acid. After 3
              min. of mixing, 12 random samples were collected in weight percent of
              tracer,10.24, 9.3, 7.94, 10.24, 11.08, 10.03, 11.91, 9.72, 10.76, 10.97,
              10.55.calculate the mixing index.

Q. 2   (A)   Derive the expression for screen effectiveness   [10]
        (B)   State and Explain in details Energy laws for crushing.   [10]

Q. 3   (A)   A crusher is reducing limestone of crushing strength 70 MN/m^2 from 6   [10]
              mm diameter size to product size of 0.1 mm diameter requires 9 KW . The
              same machine is used to crush dolomite at the same rate of output from 6
              mm diameter size to product which contains of 20% with an average di-
              ameter of 0.25 mm, 60% with an average diameter of 0.125 mm and the
              balance having an average diameter of 0.085 mm. Estimate the power re-
              quired to drive the crusher, assuming that the crushing strength of dolomite
              is 100 MN/m^2 and that crushing follows Rittinger's law.
        (B)   Derive the expression for constant pressure filtration   [10]

Q. 4   (A)   A Plate and frame press, filtering a slurry, gave a total of 8 m^3 of filtrate in   [10]
              1800 seconds and 11m^3 in 3600 seconds, when filtration was stopped. Es-
              timate the washing time in seconds if 3 m^3 of wash water was used. The
              resistance of the cloth can be neglected and a constant pressure is used
              throughout
        (B)   Derive the expression to calculate the area of thickener by any one method   [10]

Q. 5   (A)   Derive the expression for minimum fluidization velocity.   [10]
        (B)   Derive the expression to estimate the size of smallest particle that can be   [10]
              separated in cyclone separator.

Q. 6   Write short note on   [10]
        (A)   Ribbon Blender   [05]
        (B)   Degree of mixing   [05]
        (C)   Screw conveyors   [05]
        (D)   Pressures in bins and silos   [05]

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