17 DEC.2025 SE CHEMICAL (SEM-II) NEP-2020 CEM QP CODE: 20000057

Time: 3 Hours **Total Marks: 60**

N.B.

1. Question No. 1 is Compulsory.
2 Attempt any **Three** Questions from remaining **Five** Questions
3. Assume Suitable Data if needed and Justify the Same
4. Figures to the right indicate full marks.

Que.1 Solve any **FIVE**

a) Explain Types of correlations [03]

b) Find the Eigen values of 3×3 matrix are -1,2 if the determinant of matrix is 4 find third Eigen value. [03]

c) Solve $y_{n+2} - 6y_{n+1} + 9y_n = 0$ [03]

d) Find Laplace Transform of $sin^2t + e^{6t} + sin2t - 5cost$ [03]

e) Evaluate: $\frac{\Delta^2}{E} x^2$, consider h =1 [03]

f) What is the key difference between an initial value problem (IVP) and a boundary value problem (BVP)? [03]

Que.2

a) Measuring pressure drop ΔP (kPa) over pipe length L (m) [05]

L (m)	1	2	3	4	5
ΔP (kPa)	2.1	4.3	6.4	8.6	10.7

Fit the data in ΔP= a+bL and predict ΔP at L= 3.6 m.

b) Find the Eigen Value and Eigen Vector of following matrix [06]

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

c) Explain Discrete and Continuous random variables with examples [4]

Que.3

a) A dynamic model for the flow through cylindrical tank, [6]

$$\frac{dh}{dt} = \frac{F_0 - F}{\frac{\pi}{4}D^2}$$

Where, D is diameter of tank F_0 is the inlet flow rate, F is the outlet flow rate and h is the level in the tank. If the tank dimensions are as given below, find the liquid level in the tank with respect to time. Take step size of 5 second and show calculations till 10 seconds. Use Euler's method

Data : Diameter of tank=1 m, height of tank= 2 m, $F = 0.04\sqrt{h}$ in m^3/s where h is in m , F_0=0.06 m^3/s at t=0 sec, h=1 m.

b) The pressure (bar) and gas solubility (mole fraction) of CO2 in water are measured. Find Karl Pearson's correlation coefficient. [05]

Pressure	100	200	300	400	500
CO_2	30	40	50	60	70

c) What is the defining characteristic that separates higher-order RK methods from Euler's method? [4]

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Que.4

a) Solve $\frac{\partial p}{\partial t} = \frac{\partial^2 p}{\partial y^2}$ subject to the condition p(y,0)=0, p(0,t)=0, p(1,t)=80t with k=1/4, h=1/2 for a one time step using crank Nicholson method. [06]

b) Solve $y_{n+1} - 2y_n = cos2n$ [04]

c) Check whether the following matrix A is diagonalizable? [05]

$$A=\begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ -3 & 3 & 2 \end{bmatrix}$$

If so, find the diagonal form of A and transforming matrix of A.

Que.5

a) Solve $\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial t}$, given u(0,t)=0, u(4,t)=0, u(x,0)=x(4-x) assuming h=k=1 find values of u up to t=5 using bender Schmidt method [06]

b) State First Shifting Therom and Solve for $L(e^{-t}cosh4t)$ [05]

c) Solve the following Difference equation [04]

$y_{n+2} - 7y_{n+1} + 10y_n = 3^n + 4^n$

Que.6

a) A chemical reaction is carried out in batch reactor and it has been found that concentration of reactant changes as per the equation given below. [05]

$$\frac{dC_A}{dt} = \frac{C_A}{1 + 0.5{C_A}^{1.8}}$$

If initial concentration (at t=0) is 0.8 then find concentration of reactant at t=1 with step size, h=0.5 using Runge kutta second order method.

b) Solve $y_{n+2} - 6y_{n+1} + 9y_n = 0$ given $y_0 = 1,\ y_1 = 0$ [05]

c) Find the Inverse of Laplace transform of [05]

$$L^{-1}\left(\frac{4}{s^6} - \frac{2}{s^{10}} + \frac{2}{s^2 - 9} + \frac{3s}{s^2 + 25}\right)$$

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