10/06/2025 SE CHEMICAL SEM-III C-SCHEME CET-I QP CODE: 10085049

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.
(iv) Figures to the right indicate full marks

Q1 Explain **any Four**: **20**

(a) Carnot cycle and its principle
(b) Exergy and its applications
(c) Fugacity and fugacity coefficient
(d) First law of thermodynamics for closed system
(e) Maxwell Equations

Q2 (a) Two kilograms of CO_2 gas is contained in a piston-cylinder assembly at a pressure of 6.5 bar and a temperature of 300K. the piston has a mass of 5000kg and a surface area of $1m^2$. The friction of the piston on the walls is significant and cannot be ignored. The atmospheric pressure is 1.01325 bar. The latch holding the piston in position is suddenly removed and the gas is allowed to expand. The expansion is arrested when the volume is double the original volume. Determine the work appearing in the surrounding. **10**

(b) Explain Kelvin and Clausius statement of second law of thermodynamics **10**

Q3 (a) Oil at500K is to be cooled at a rate of 5000kg/h in a counter current exchanger using cold water available at 295K. a temperature approach of 10 K is to be maintained at both ends of the exchanger. The specific heats of oil and water are respectively 3.2 and 4.2 kJ/kg.K. Determine total entropy change in the process. **10**

(b) Derive the Clausius inequality. **10**

Q4 (a) Carbon dioxide at 1 bar and 300K is to be compressed to a pressure of 10 bar in a single stage compressor at a rate of $100m^3/h$. assuming that CO_2 behaves as an ideal gas, calculate the temperature of the gas after compression and the work required. **10**
Take $\gamma = 1.3$

(b) Prove that a Carnot engine has the maximum efficiency and that the efficiency is independent of the working fluid. **10**

Q5 (a) Using Virial equation of state calculate the molar volume and compressibility factor of isopropanol vapor at 473 K and 10 bar. The virial coefficients are: $B = -3.88\times10^{-4}$ m^3/mol ; $C = -2.6\times10^{-8}$ m^6/mol^2 **10**

(b) Prove that compressibility factor at critical point (Z_c) for a Vander Waals gas is equal to $\frac{3}{8}$. **10**

Q6 (a) Calculate the fugcity of methane gas at 322K and 55 bar, given that the critical constants are 190.7 K and 46.4 bar. **10**

(b) Explain T-S diagram with its applications **10**

02/06/2025 SE CHEMICAL SEM-III C-SCHEME EM-III QP CODE: 10083689

(3 Hours) **Total Marks: 80**

Note: 1) Question No.**1** is **compulsory.**
2) Attempt **any THREE** from the remaining.
3) Figures to the right indicate full marks**.**

Q.1 **A)** Find the values of constants a,b,c and d if **5**
f(z) = $(x^2 + 2axy + by^2) + i(cx^2 + 2dxy + y^2)$ is analytic

B) Find the Eigen Value of $A^3 - 3A^2$ **5**
Where A = $\begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{bmatrix}$

C) Find the Laplace Transform of t sin at **5**

D) Find the Fourier series expansion for f(x) = x defined in (-1,1) **5**

Q.2 **A)** If L[f(t)] = $\frac{s}{s^2+s+4}$ find L[$e^{-3t}f(2t)$] **6**

B) Find the Fourier series expansion for f(x) = x defined in $(-\pi, \pi)$ with period 2π **6**

C) Find the analytic function f(z) with the real part u = $x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$ **8**

Q.3 **A)** Show that the function u = $x^3 - 3xy^2$ is harmonic function. **6**
Hence find the corresponding analytic function and harmonic conjugate.

B) A string is stretched and fastened to two points distance L apart motion is started by displacing the string in the form u =$\alpha \sin(\frac{\pi x}{L})$ from which it is released at time t = 0. Show that the displacement of a point at a distance X from one end at time t is given by u(x,t) = $\alpha \sin\left(\frac{\pi x}{L}\right) \cos(\frac{\pi ct}{L})$ **6**

C) Obtain the Fourier series expansion of f(x) = $|x|$ where $-\pi \leq x \leq \pi$ **8**

Q.4 **A)** Find Laplace transform of $e^{-4t}\int_0^t usin3u\, du$ **6**

B) Find Inverse Laplace transform of $\frac{2s+3}{s^2+2s+2}$ **6**

C) Verify Cayley – Hamilton theorem for the matrix A and hence find A^{-1} & A^4 **8**
where A = $\begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$

Q.5 **A)** Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial u}{\partial t} = 0$,$0 \leq x \leq 1$ **6**
subject to the condition u(0,t) = 0,u(1,t) = 100t , u(x,0) = 0, h = $\frac{1}{4}$
for one –time step.

B) Find the inverse Laplace transform of log $\left(\frac{s+a}{s+b}\right)$ **6**

C) Show that the matrix A = $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 7 \end{bmatrix}$ is diagonalizable. **8**
Find transforming matrix and diagonal Matrix.

Q.6 **A)** Evaluate $\int_0^\infty e^{-3t}\, t\, sint\, dt$ using Laplace transform. **6**

B) Find the solution $u_t = u_{xx}$ subject to u(0,t) = 0,u (5,t) = 0,u (x,0) = $x^2\,(25 - x^2)$ **6**
using Schmidt method taking h = 1 up to 3 seconds.

C) Find the inverse Laplace transform of $\frac{s}{(s^2+1)^2}$ using convolution theorem. **8**

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06/06/2025 SE CHEMICAL SEM-III C-SCHEME FFO QP CODE: 10081005

Time: 3 Hours **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
(4) Figures to the right indicate full marks.

Q1 **Solve any Four out of Five** **20**

a) Write a short note on Surface Tension.

b) Two horizontal plates are placed 1.25 cm apart, the space between them being filled with oil of viscosity 14 poises. Calculate the shear stress in oil if upper plate is moved with a velocity of 2.5 m/s.

c) Differentiate between NPSHA and NPSHR.

d) What are the various types of losses occurring in pipe

e) Define Newtonian and Non- Newtonian fluids with suitable examples.

Q2

a) A 30 cm diameter pipe, conveying water ,branches into two pipes of diameters 20 cm and 15 cm respectively .If the average velocity in the 30 cm diameter pipe is 2.5 m/s, find the discharge in this pipe Also determine the velocity in 15cm pipe ,if the average velocity in 20 cm diameter pipe is 2 m/s. **10**

b) State the Bernoulli's theorem for compressible flow. Derive an expression for Bernoulli's equation for Isothermal process. **10**

Q3

a) An inverted U-tube manometer is connected to two horizontal pipes A and B through which water is flowing. The vertical distance between the axes of these pipes is 30 cm. When an oil of specific gravity 0.8 is used as a gauge fluid, the vertical heights of water columns in the two limbs of the inverted manometer (When measured from the respective centre lines of the pipes) are found to be same and equal to 35cm. Determine the difference of pressure between the pipes. **10**

b) Derive an expression for Hagen Poiseuille's equation? **10**

Q4

a) What is an Orificemeter? Derive an expression for the discharge through Orificemeter. **10**

b) An oil of specific gravity 0.7 is flowing through the pipe of diameter 300 mm at the rate of 500 lit/sec. Find the head lost due to friction and power required to maintain the flow for a length of 1000 m. Take kinematic viscosity as 0.29 stokes. **10**

Q5

a) Derive an expression for terminal settling velocity for a one dimensional motion of a particle in a fluid. **10**

b) Calculate the stagnation pressure, temperature and density at the stagnation point on the nose of a plane, which is flying at 800 km/hour through still air having a pressure 8 N/cm^2 (abs.) and temperature -10^o C. Take R= 287 J/(kg K) and k=1.4. **10**

Q6

a) Explain the characteristics curves of centrifugal pump **10**

b) Explain Gate valve and Globe valve with neat sketch. **10**

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04/06/2025 SE CHEMICAL SEM-III C-SCHEME IEC-I QP CODE: 10082502

Time: 3 Hours **Marks:80**

N.B.: 1. Questions no. 1 is compulsory.

2. Attempt any three questions from remaining five questions

Q1. **Attempt any four questions of the following** **[20]**

a. Write the chemical formula of the following co-ordination compounds.
   (i) Dicyanoargentate (i) ion
   (ii) Tris (ethylenediamine) chromium (iii) chloride
b. Discuss the synthesis of Alizarin with reaction
c. Explain E&Z system of Nomenclature
d. Describe the conductometric titration of strong acid Vs weak base .
e. Explain Lanthanide separation in detail.
f. Discuss thermodynamically and kinetically controlled reaction wrt sulphonation of naphthalene.

Q2. a. What is EAN? Calculate EAN of $[Pt(NH_3)_4]^{2+}$ [5]

b. Explain inductive effect and hyper conjugation with suitable example to explain the stability of Carbocation. [5]

c. Define the terms ((i)specific conductance,
(ii)equivalent conductance
(iii)molar conductance [5]

d. Explain role of complexing agent in solvent extraction. [5]

Q.3. a. What is CFSE? Calculate CFSE OF d^4 and d^7 in octahedral complexes. [5]

b. The speed ratio of silver and nitrate ions in a solution of silver nitrate electrolysed between silver electrodes is 0.916. Find the transport number of silver and nitrate ions. [5]

c. Explain the applications of cytochrome. [5]

d. Explain the reaction with mechanism when 1,2 vicinal diols are heated with sulphuric acid. [5]

Q.4. a. Write a note on optical isomerism of lactic acid. [5]

b. Explain the role of following nutrients in plant growth-
(i) N (ii) P (iii) K [5]

c. Define the terms -Coordination number and ligands. Explain the types of ligands with suitable examples [5]

d. Explain determination of transport number by moving boundary method. [5]

Q.5. a. Explain preparation, and bonding involved in $Fe_2(CO)_9$ [5]

b. Explain effect of temperature and dilution on conductance. [5]

c. Explain the manufacture of ammonium sulphate. [5]

d. State Nernst distribution law and explain an expression for amount of solute left unextracted after single extraction. [5]

Q.6.a. Write the IUPAC names of the following co-ordination compounds,
(i) $(NH_4)_3[Cr(SCN)_6]$, (ii) $[Co(NH_3)_6]Cl_3$ [5]

b. Differentiate between Enantiomers and Diastereomers with suitable example. [5]

c. Differentiate between Transition state and Intermediate. [5]

d. 250ml of an aqueous solution containing 0.30g of solute X is extracted two times with 30ml of organic solvent. What will be the amount of solute remain in aqueous solution, if the distribution ratio in favour of ether is 15.5. [5]

12/06/2025 SE CHEMICAL SEM-III C-SCHEME PC QP CODE: 10079609

Time: 3 hours **Marks: 80**

N.B. : 1) Question No.1 is compulsory
2) Answer any three questions from remaining questions
3) Assume data if necessary and specify assumptions clearly

Q.1 a) An aqueous of Acetic Acid **(CH_3COOH)** of 30% concentration (by mass) has density 1040 kg/m3. Find Molality, Normality and Molality of the solution. **[5 marks]**

b) A natural gas has the following composition by volume, Calculate the density of the gas at 288 K and 101.325. **[5 marks]**
CH_4 = 82 % , C_2H_6 = 12 % and N_2 = 6 %

c) Write short note on Heat of Reaction and Heat of Formation **[5 marks]**

d) Define limiting reactant, conversion, yield and selectivity , **[5 marks]**

Q.2 a) A dryer is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the dryer is sent to oven to reduce the moisture content to 2%. If 1000 kg of wet solid is fed to the dryer, find out the weight of the products leaving the dryer and oven. Also determine the amount of water removed in dryer and in oven. **[10 marks]**

b) The spent acid from a nitrating process contains 21 % HNO_3, 55 % H_2SO_4 and 24 % H_2O by weight. This acid is to be concentrated to contain 28% HNO_3 and 62 % H_2SO_4 by addition of concentrated sulphuric acid containing 93% H_2SO_4 (by weight) and concentrated nitric acid containing 90% HNO_3 (by weight). Calculate the weights of spent acid, concentrated suphuric acid and concentrated nitric acid that must be combine to obtain 1000 kg of the desired mixture. **[10 marks]**

Q.3 a) A solution of potassium dichromate in water contains 15% potassium dichromate by weight. 1000 kg of this solution is evaporated to remove some of water. The remaining solution is cooled to 298 K. If the yield of potassium dichromate crystals is 75%, calculate the amount of water evaporated. Solubility of potassium dichromate in water is 115 kg per 1000kg water. **[10 marks]**

b) Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction: **[10 marks]**

$$\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$$

Data: ΔH^0_R= -46.222 kJ

C_p^0 = a+bT+cT^2 , J/(mol.K)

Component	a	B×10^3	C×10^6
NH_3	25.48	36.89	-6.305
N_2	27.31	5.2335	-4.1868
H_2	29.09	-8.374	2.0139

Q.4 a) Formaldehyde is Produced by dehydrogenation of methanol. **[10 marks]**

$CH_3OH \longrightarrow HCHO + H_2$

The per pass conversion is 67 %. The product leaving the reactor is fed to a separation unit battery where formaldehyde is separated from methanol and hydrogen. The separated methanol is recycled to the reactor. If the production rate of formaldehyde is 1000 kg/h. Calculate: The combined feed ratio, Recycle ratio and The flow rate of methanol required to the process as fresh feed.

b) Oxidation of ethylene to produce ethylene oxide is given by reaction: **[10 marks]**

$C_2H_4 + \frac{1}{2}O_2 \longrightarrow C_2H_4O$

If air is used 20 % in excess of that theoretically required, calculate the quantity of air supplied based on 100 kmol of ethylene fed to the reactor.

Q.5 a) A vapour at 411 K and Standard atmospheric pressure, containing 0.72 mole fractions Benzene and 0.28 mole fractions Toluene serve as a feed to a fractionating column in which it is separated in to a distillate containing 0.995 mole fraction Benzene and bottoms with 0.97 mole fraction Toluene. The reflux ratio is desired to be 1.95 kmol/kmol of distillate product. For a feed of 100 kmol, compute the overall material and energy balances. Assume that there is no heat loss to the surrounding and the heat of solution is negligible. **[10 marks]**

Enthalpy of Vapours(overhead)=42170 kJ/kmol mixture
Enthalpy of liquid(overhead)=11370 kJ/kmol mixture
Specific enthalpy of bottom product= 18780 kJ/kmol mixture
Enthalpy of feed = 44500 kJ/kmol

b) Temperature of oxygen is raised from 850 K to 1500 K. calculate the amount of heat that must be supplied for raising the temperature of 1 kmol oxygen using C_P^0 data given below. **[10 marks]**

C_P^0 For oxygen = $26.0257 - 11.7551 \times 10^{-3} T - 2.3426 \times 10^{-6} T^2 - 0.5623 \times 10^{-9} T^3$.

Q.6 a) Calculate the standard heat of formation of liquid methanol. **[20 marks]**

Data:
Std. Heat of combustion of methanol= -726.55 kJ/kmol
Std. Heat of formation of gaseous CO_2 = -393.51 kJ/kmol
Std. Heat of formation of liquid H_2O = -285.84 kJ/kmol

b) In the production of SO_3, 100 Kmol of SO_2, and 200 Kmol of O_2 are fed to the reactor , The product stream are found to contain 80 Kmol of SO_3Find the percentage conversion of SO_2

c) Explain recycle and purge operation in detail

d) Explain Hess's law