2013-14
B.TECH. 2nd Year (IV SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
ENGINEERING CHEMISTRY & MATERIAL SCIENCE
AC-211

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question  M.M.

1(a) What are unit cells? Draw the unit cells for Face Centred Cubic (FCC) and
Hexagonal Close Packed (HCP) structures. Calculate the number of atoms in each
case.

(b) Write explanatory notes on any TWO of the following:
   (i) Crystal system
   (ii) Inter-planar spacing
   (iii) Frenkel defect

2(a) What are engineering materials? How are they classified?

(b) Differentiate between carbon steel and stainless steel. Give the general
composition, characteristic properties and uses of martensitic stainless steel.

(c) Give the composition, properties and uses of white cast iron.

OR

2*(a) What are low alloy steels? Discuss the properties and uses of different types of low
alloy steels.

(b) Give the general composition, properties and uses of grey cast iron.
3(a) Draw and discuss the phase diagram of Pb–Sn system.

(b) Write explanatory notes on any TWO of the following:
   (i) Invariant reactions in Fe–Fe₃C Phase Diagram
   (ii) Solid phases in Fe–Fe₃C Phase Diagram
   (iii) Component and degree of freedom

4 Discuss any TWO of the following:
   (i) Principle and objectives of heat treatment
   (ii) TTT diagram for eutectoid steel
   (iii) Annealing

5(a) What do you understand by thermogravimetric analysis? Name the various methods used in thermal analysis and also mention the property which is measured by each method.

   (b) What is the principle of differential thermal analysis? Explain the various transformations occurring in DTA curve with suitable examples.

   (c) Draw the block diagram of scanning electron microscope and write the function of each component.

6(a) What is the Lewis theory? Highlight its drawbacks.

   (b) How relative strength of weak acid and weak bases are calculated from Kₐ and K_b?

   (c) Describe the Moving Boundary Method for the determination of transport number.

   OR

   (c') What do you understand by equivalent conductance? Discuss its variation with concentration of electrolytes. Why specific conductance decreases while equivalent conductance increases on dilution?
1. (a) A particle moves along the curve \( x - e^{-t}, y = 2 \cos 3t, z = 2 \sin 3t \), where \( t \) is the time variable. Determine its velocity and acceleration at \( t = 0 \).

OR

(a') Find the angle between the surfaces \( x^2 + y^2 + z^2 - 9 \) and \( z = x^2 + y^2 - 3 \) at the point \((2, -1, 2)\).

(b) Find the directional derivative of \( \phi = 2xy + 5yz + zx \) at the point \((1, 2, 3)\) in the direction of \( 3\mathbf{i} - 5\mathbf{j} + 4\mathbf{k} \).

(c) A fluid motion is given by \( q = (y + z)\mathbf{i} + (z + x)\mathbf{j} + (x + y)\mathbf{k} \)

(i) Is this motion irrotational? If so, find the velocity potential.

(ii) Is the motion possible for an incompressible fluid?

2. (a) Verify Green's theorem in the plane for \( \int_C ([x^2 - y^2]dx + 2xydy) \) where \( C \) is the closed curve of the region bounded by \( y = x^2 \) and \( y^2 = x \).

OR

(a') Show that \( \mathbf{F} = (2xy + x^2)\mathbf{i} + x^2\mathbf{j} + 3z^2x\mathbf{k} \) is a conservative field. Find its scalar potential and also the work done in moving a particle from \((1, -2, 1)\) to \((3, 1, 4)\).

(b) Verify Stokes' theorem for \( \mathbf{F} = -x^2\mathbf{i} + xy\mathbf{j} \) in the square region in the XOY plane bounded by the lines \( x = 0, y = 0, x = a, y = a \).

(c) Verify the divergence theorem for \( \mathbf{F} = 4xz\mathbf{i} - y^2\mathbf{j} + yz\mathbf{k} \) over the cube bounded by \( x = 0, x = 1, y = 0, y = 1, z = 0, z = 1 \).

3. (a) Evaluate the following:

(i) \( L\left(\frac{1 - \cos t}{t}\right) \)

(ii) \( L^{-1}\left(\frac{\cot^{-1} s}{k}\right) \)

where \( L \) denotes Laplace transform.

Contd....2
(a') Using convolution theorem find \( f(t) \) if \( \mathcal{L}[f(t)] = \frac{s^2}{(s^2 + a^2)(s^2 + b^2)} \)

(b) Using Laplace transform method, solve the differential equation
\[ y''(t) + 9y(t) = 18t \]
given that \( y(0) = 0 \) and \( y\left(\frac{\pi}{2}\right) \).

(c) An alternating e.m.f. \( E \sin wt \) is applied to an inductance \( L \) and a capacitance \( C \) in series. Show that the current in the circuit is
\[ \frac{E}{L(R^2 - n^2)} \left( \cos wt - \cos nt \right) \],
where \( n^2 = \frac{1}{LC} \).

OR

(c') (i) Obtain the Laplace transform of the periodic saw tooth wave represented in the figure below:

(ii) Define Heaviside's unit step function and find its Laplace transform.

[4.5.6]

4. (a) An infinitely long plane uniform plate is bounded by two parallel edges at an angle at right angles to them. The breadth is \( \pi \); this end is maintained at a temperature \( u_0 \) at all points and the other edges are at zero temperature. Show that in the steady-state, the temperature is given by
\[ u = \frac{4u_0}{\pi} \left[ e^{-x} \sin x + \frac{1}{3} e^{-3x} \sin 3x + \cdots \right] . \]

(b) A tightly stretched string with fixed end points \( x = 0 \) and \( x = \ell \) is initially displaced in a sinusoidal arch of height \( y_0 \) and then released from rest. Find the displacement \( y \) at any distance \( x \) form one end at time \( t \). Show that each point of the string has simple harmonic motion. Find the period.

(c) Solve the partial differential equation \( \frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} \) by the method of separation of variables.

[6.6,3]
2013 – 2014
B.TECH. WINTER (IV SEMESTER) EXAMINATION
(COMPUTER ENGINEERING)
(NUM. ANALYSIS, TRANSFORMS & PROBABILITY)
(AM – 262)
Credits : 04

Maximum Marks: 60

Duration: Three Hours

Note: Answer all questions. Programmable calculators are not allowed.

1. (a) Find the Laplace transform of \( \frac{\sin at}{t} \). Does the Laplace transform of \( \frac{\cos at}{t} \) exist? [04]

(b) State convolution theorem. Find \( L^{-1}\left(\frac{1}{s(s+a)(s-a)}\right) \) by convolution theorem. [06]

OR

(b') Solve the initial value problem by Laplace method
\[ (D^2 + n^2)x = a \sin (nt + a), \quad x_0 = 0 = x_1. \] [06]

(c) An alternating voltage 250 sin 100t applied at \( t = 0 \) to a circuit with an inductance 50mH, capacitance 400\( \mu \)F and resistance 10Ω. Find the current \( I \) at time 1 second if the initial current and charge are zero. [05]

2. (a) Find the interpolating polynomial of degree two approximating the function \( y = \ell_n x \) using Lagrange's interpolation. Hence determine the value of \( y(2.7) \). [06]

Given:

<table>
<thead>
<tr>
<th>( x )</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = \ell_n(x) )</td>
<td>0.69315</td>
<td>0.91629</td>
<td>1.09861</td>
</tr>
</tbody>
</table>

(b) Find the solution of the system of linear equations
\[
\begin{align*}
7x + 52y + 13z &= 104 \\
83x + 11y - 4z &= 95 \\
3x + 8y + 29z &= 71
\end{align*}
\] [05]

Using Gauss-Seidel method with three iterations.

(c) Find the real root of the equation
\[
x - \frac{x^2}{3} + \frac{x^3}{10} - \frac{x^4}{42} + \frac{x^5}{216} - \cdots = 0.4431
\] [04]

Correct to four decimal places by general iteration method.

3. (a) Compute the values of \( I = \int \frac{dx}{1 + x^4} \) by using trapezoidal rule with \( h = 0.125 \). [08]

Obtain a better estimate by Simpson's 1/3 rule.

Contd...2
(b) Evaluate \( \int_1^2 \frac{2x}{1+x^2} \, dx \) using 2-point and 3-point Gauss Quadrature formula. Also discuss the error in both case.

OR

(b') Given initial value problem \( y' = 3x + \frac{1}{2}y \) with initial condition \( y(0) = 1 \). Calculate \( y \) at \( x = 0.5 \) by Runge-Kutta method of order 4 with \( h = 0.5 \). Also discuss the order of convergence.

4. (a) (i) Define conditional probability for two events \( A \) and \( B \), \( P(A) = 0.5 \), \( P(B) = 0.6 \), \( P(A \cup B) = 0.8 \). Find \( P(A|B) \) and \( P(B|A) \).

(ii) If \( A, B \) and \( C \) are mutually independent events, then show that \( (A \cup B) \) and \( C \) are independent events.

(b) An experiment consists of three independent tosses of a fair coin.

Let \( X = \) the number of heads
\( Y = \) the number of head runs
\( Z = \) the length of head runs.

A head runs being defined as consecutive occurrence of at least two heads and its length is defined as the number of heads occurring together in 3-tosses of coin. Find the probability of

(i) \( X \)  (ii) \( Y \)  (iii) \( Z \).

Construct the probability distribution table and draw their probability chart.

OR

(b') (i) A continuous random variable \( x \) has the probability density function
\[
 f(x) = \begin{cases} 
 a + bx, & 0 \leq x \leq 1 \\
 0, & \text{elsewhere} 
 \end{cases} 
 \]
If the mean of the distribution is \( 1/3 \), then find the values of \( a \) and \( b \).

(ii) A target is to be destroyed in a bombing exercise. There is 75% chance that any one bomb will strike the target. Assume that two direct hits are required to destroy the target completely. How many bombs must be dropped in order that the chance of destroying the target is \( \geq 99\% \)?

(c) State main characteristics of Normal probability curve. If \( X \sim N(\mu, \sigma^2) \) and \( Y \sim N(\mu, \sigma_{y}^2) \), then plot the curve for \( \sigma_1 < \sigma_2 \), where the symbols have their usual meanings.
Q.No.

1. (a) Define Continuum. Explain the axioms of rheology. Draw neat and well labelled rheological diagrams for two and three parameter models.

OR

1. (a') Identify the following statements as true or false with reasons.

(i) Irrotational flow implies continuity of flow
(ii) Existence of stream function implies continuity of flow.
(iii) For a possible irrotational flow there must be laplacian.
(iv) Intersection of two streamlines implies a stagnation point.
(v) A fluid for which density changes with pressure will always give rise to a compressible flow.

1. (b) The velocity distribution in a viscous flow over a plate is given by \( u = \frac{4y}{y^2} \) for \( y \geq 2 \) m, where \( u \) = velocity in m/s at a point distant \( y \) from the plate. If the coefficient of dynamic viscosity is 1.5 Pa·s, determine the shear stress at \( y = 0 \) and at \( y = 2.0 \) m.

1. (c) Describe briefly the temperature and pressure dependence of viscosity of liquids and gases.

2. (a) Describe hydrostatic law for a fluid in static position. Obtain the expression for hydrostatic pressure below the free surface of the fluid relative to pressure at free surface for an incompressible and compressible fluid.

OR

2. (a') State Archimedes Principle. Discuss in detail the stability of Submerged body and Floating body in fluid.

2. (b) Pressure gauge B is to measure the pressure at point A in a water flow as shown in figure below. If the pressure at B is 87 kPa, estimate the pressure at A, in kPa. Assume all fluids are at 20°C. Given: \( \rho_{\text{water}} = 9790 \text{ N/m}^3 \), \( \rho_{\text{mercury}} = 133100 \text{ N/m}^3 \), \( \rho_{\text{oil}} = 8720 \text{ N/m}^3 \).
3. (a) Compare and discuss the Eulerian and Lagrangian approaches to the study of fluid motion. Explain the derivatives present in these approaches with a suitable example.

OR

3. (a) Define and derive the relationship for vorticity and circulation of flow. Find out the circulation for irrotational vortex flow pattern.

3. (b) What are flow nets? How are they helpful in the study of fluid motion? Explain with the help of a neat and labelled diagram.

OR

3. (b) Discuss the formation of boundary layer inside a pipe for laminar as well as turbulent flow. Discuss boundary layer separation for convergent and divergent flows.

4. (a) Describe the geometric, kinematics and dynamic similarity of the two models. A model of an air duct operating with water produces a pressure drop of 10 kPa over 10 m length. If the scale ratio is 1/50, \( \rho_w = 1000 \ \text{kg/m}^3 \), \( \rho_a = 1.2 \ \text{kg/m}^3 \), \( \mu_w = 1 \ \text{cP} \) and \( \mu_a = 0.02 \ \text{cP} \), estimate the corresponding pressure drop in a 20 m long air duct.

4. (b) The force \( (F) \) on the propeller of an aircraft is known to depend upon the forward speed of the aircraft \( (V) \), the independent variables of the fluid properties \( (\rho \text{ and } \mu) \), the diameter of the propeller \( (D) \), and the speed of rotation of the propeller \( (N) \). Establish a relationship amongst these parameters using Buckingham Pi Theorem in the form of suitable dimensionless groups. Explain the significance of each of the dimensionless groups thus formed.

5. (a) Classify the flow meters into variable head and variable area meter. Discuss any flowmeter in detail and derive the expression for the volumetric flow rate of the fluid using that flowmeter.

5. (b) Briefly describe the working principle of a centrifugal pump and positive displacement pump. Highlight the benefits of using centrifugal pumps in series and parallel arrangement. Explain what is meant by available and required net positive suction head (NPSH), cavitation, and specific speed of a centrifugal pump.
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
MATERIAL SCIENCE AND ENGINEERING MATERIALS
CIT 223

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No.  Question                                      M.M.
1(a)  Draw a square close packing and hexagonal close packing of constituent particles in a crystal. Also, write their coordination number. [02]
1(b)  Draw a (111) and (112) plane inside the unit cell of a cubic crystal. Determine the Miller Indices of the direction that is common to both these planes. [03]
1(c)  What is the significance of Coordination Number and Packing Factor? Determine the total number of effective lattice point per unit cell and Packing Factor for Simple Cubic, Body Centred Cubic and Face Centred Cubic crystals. [06]

OR

1(e') A diffraction pattern of a cubic crystal of lattice parameter, \( a = 3.16 \, \text{Å} \), is obtained with monochromatic x-ray beam of wavelength 1.54 Å. The first four lines on this pattern were observed to have the following values:

<table>
<thead>
<tr>
<th>Line</th>
<th>( \theta ) (in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20.3</td>
</tr>
<tr>
<td>2</td>
<td>29.2</td>
</tr>
<tr>
<td>3</td>
<td>36.2</td>
</tr>
<tr>
<td>4</td>
<td>43.6</td>
</tr>
</tbody>
</table>

Determine the inter planer spacing and the Miller Indices of reflecting plane. [06]

1(d) Classify the engineering materials, both on the basis of nature and their application with suitable examples. [04]

2(a) What is Phase diagram? Sketch an \( \text{Al}_2\text{O}_3 - \text{Cr}_2\text{O}_3 \) phase diagram on the basis of... [10]

contd...
following points:
The melting point of pure $\text{Al}_2\text{O}_3 = 2050 ^\circ \text{C}$
The melting point of pure $\text{Cr}_2\text{O}_3 = 2275 ^\circ \text{C}$
The two components form a solid solution type of an alloy.

(i) Apply the Phase rule to this system and find out the degrees of freedom at different regions of the phase diagram.

(ii) Illustrate and explain the various microstructural changes occurring during cooling of an alloy having an overall composition of 73% $\text{Cr}_2\text{O}_3$ (7.7% $\text{Al}_2\text{O}_3$).

2(b) Explain the tensile stress–strain curve for Plastic deformation in a crystalline material.

OR

2(a) What are phase transformations? Discuss the time scale for phase changes?

2(b) Discuss the formation of coarse pearlite, fine pearlite and bainite with the help of TTT diagram for austenite to pearlite transformation in steel.

3(a) What are the distinguishing features of Grey Cast Iron and White Cast Iron? Discuss the properties and uses of Grey, White and Malleable Cast Iron.

3(b) Give a brief classification of materials of construction used in chemical process industries.

OR

3(b') Define cost rating factor of a material and explain its role in the selection of materials.

4(a) Define Pilling Bed Worth Ratio and explain its significance. Discuss the mechanism by which oxidation corrosion proceeds and also explain various oxidation rate laws.

OR

4(a') Write short notes on:
(i) Stress corrosion cracking
(ii) Intergranular corrosion

4(b) What are glasses and how are they classified? Write down the composition, properties and uses of Soda-Lime glass.
1(a) What are lipids? What function do they perform in a human body? Also give their brief classification. [03]

1(b) Explain some physical and chemical properties of fatty acids with specific examples. Name some methods to classify them. [05]

OR

1(b') Give a detailed classification of proteins. [05]

1(c) Explain TAGS in detail along with their physical and chemical properties. What function do they play in storing energy in a human body. [05]

OR

1(c') Name some amino acids along with their physical properties. Discuss various reactions that amino acids undergo during metabolism. [05]

1(d) What is the significance of the following
(i) Specific function
(ii) Inorganic content
(iii) Isoelectric point. [02]

2(a) Give a detailed description of subcellular organelles and cell membranes. [05]

2(b) Elaborate various Transport mechanisms necessary for cellular metabolism. [04]

2(c) Classify enzymes along with specific reactions. What is the mode of action of enzymes? Brieﬂy explain the factors affecting enzymes activity. [06]

3(a) Explain in detail the processes of transcription and translation in cell. [07]
OR

3(a) Give the brief description of various cell components, Explain the process of information storage in cells [07]

3(b) What is PCR technology? Give its setup requirements, procedure involved and stages. [08]

4(a) Explain in detail the classification of microorganisms. [3.5]

4(b) What are the influences of environmental parameters (Extrinsic and Intrinsic) on microorganisms? [04]

4(c) Give the importance of microorganisms in any three of the following fields [7.5]

(i) Digestion
(ii) Foods and vegetables
(iii) Milk and milk products
(iv) Agriculture: Enhancement in soil fertility
(v) Waste water treatment

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2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
NUMERICAL METHODS IN CHEMICAL ENGINEERING
CH-226

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No. M.M.

1(a) The overflow water is discharged from a dam with a flow approximately equal to

\[ Q = MbH^{0.5} \]

Where, \( Q \): Flow rate (9 m\(^3\)/s)
\( H \): Height of the pool (m)
\( M = 3.27 + 0.4H/P \)
\( P = 14 \) m
\( b \): Breadth of the area of overflow (1m)

Use a suitable method to find the value of \( H \). Use 4 iterations.

1(b) Evaluate \( \sqrt{12} \) by Newton’s formula

1(c) Using Regula Falsi Method, find the real root of the following equation correct to three decimal places

\[ x \log_{10} x = 1.2 \]

OR

1’ Solve the following system of equations

\[ 10 W + X + Z = 12 \]
\[ W + 10 X + Z = 12 \]
\[ W + X + 10 Z = 12 \]

Using Gauss-Jordan elimination method

2 Find the solution of the following system of equations

\[ 20 X + Y - 2 Z = 17 \]
\[ 3 X + 20 Y - Z = -18 \]
\[ 2 X - 3 Y + 20 Z = 25 \]

contd...
By Gauss–Seidel iterative method, perform first three iterations.

3(a) Find the approximate value of

\[ Y = \int \sin x \, dx \]

Using Simpson’s 1/3 rule dividing the range of integration into six equal parts

3(b) The sales in a particular Department Store for the last five years is given in the following table:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (in lakhs)</td>
<td>40</td>
<td>43</td>
<td>48</td>
<td>52</td>
<td>57</td>
</tr>
</tbody>
</table>

Estimate the sales for the year 1979 using any suitable method for interpolation.

4 Given \( \frac{dy}{dx} = 4e^{0.8x} - 0.5 \) y from \( x=0 \) to \( x=4 \) with a step size of 1. The initial condition at \( x=0 \) is \( y=2 \).

Find the solution using any suitable method.
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL / PETRO-CHEMICAL ENGINEERING
ELECTRONICS AND INSTRUMENTATION
EL-202

Maximum Marks: 60 Credits: 03 Duration: Three Hours

Answer all the questions. Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question

1(a) Perform the following conversions:
   (i) $2496_{10} = (?)_{8}$
   (ii) $(CF5)_{16} = (?)_{10}$
   (iii) $(11011.0111)_{2} = (?)_{10}$

   OR

1(a') Simplify the expression $z = \overline{A}BC + \overline{A}BC + ABC$.

1(b) With the help of clocked JK flip flops and waveforms, explain the working of a three bit binary ripple counter.

1(c) What is meant by multiplexer? List out its various applications.

2(a) Define a transducer. List five physical quantities that transducer measures.

2(b) Explain the operating principle of a Ramp type DVM.

2(c) What is an LVDT? Explain the operating principle of an LVDT.

   OR

   Define a strain gauge. Distinguish between bonded and unbonded strain gauges.

2(c') Explain microprocessor based system and their impact on modern society.

3(a) Explain the architecture of 8085 microprocessor with a neat diagram.

3(b) What are the different types of flags available in 8085 microprocessor? Explain each in brief.

3(b') What are the different types of flags available in 8085 microprocessor? Explain each in brief.
Q1(a) What is a Carnot engine? Why thermal efficiency of 100% is not possible for heat engine? [02]

Q1(b) A Carnot heat engine operates between two thermal reservoirs at temperature $T_1$ & $T_2$ ($T_2 < T_1$). If the working medium of the engine is an ideal gas prove that energy conversion efficiency of the engine is always equal to or less than one. [04]

Q1(c) A rigid and insulated tank of volume 2 m$^3$ is divided into two equal compartments by a partition. One compartment contains an ideal gas at 400K and 1 MPa, while the second compartment contains the same gas at 600K and 1 MPa. The partition is punctured and the gases are allowed to mix. Determine the entropy change of the gas. The isobaric molar heat capacity of the gas equal to $(5/2) R$. [06]

Q1(d) Explain with a Schematic diagram the working of an absorption refrigeration system. [03]

OR

Q’1(a) Derive the work required in the case of Isothermal and Adiabatic process. [02]

Q’1(b) A reversible heat engine A absorbs energy from a reservoir at $T_1$ and rejects energy to a reservoir at $T_2$. A second reversible engine B absorbs the same amount of energy as rejected by the engine A, from the reservoir at $T_1$ and rejects energy to a reservoir at $T_2$.

Determine the expression of $T_2$ in terms of $T_1$ and $T_3$ if
(i) The efficiency of engines A and B are the same.
(ii) The work delivered by the engines is the same. [04]

Q’1(c) The Ideal gas undergoes the following sequence of mechanically reversible processes in a closed system.
(i) For an initial state of 343.15K and 1 bar, it is adiabatically compressed to 423.15K.
(ii) It is then cooled from 423.15 to 343.15K at constant pressure.
(iii) Finally, it is expanded isothermally to its original state.
Calculate $W$, $Q$, $\Delta U$ and $\Delta H$ for each of the three processes and for the entire cycle. Take $C_v=5/2 R$ and $C_p=5/2 R$. [06]
Q1(d) Differentiate between Claude and Linde liquefaction process with the help of their line diagram.

Q2(a) Show that for a pure species coexisting liquid and vapour phases are in equilibrium when they have the same temperature, pressure, chemical potential and fugacity.

Q2(b) The excess Gibbs energy of a binary liquid mixture at \( T \) and \( P \) is given by:

\[
\frac{G^{\text{ex}}}{RT} = (-2.6x_1 - 1.8x_2) x_1 x_2
\]

(i) Find expressions for \( \ln \lambda_1 \) and \( \ln \lambda_2 \) at \( T \) and \( P \).
(ii) Show that when these expressions are combined in accord with Summability equation, the given equation for \( \frac{G^{\text{ex}}}{RT} \) is recovered.
(iii) Show that \( d \ln \lambda_1 / dx_1 \bigg|_{x_2} = d \ln \lambda_2 / dx_2 \bigg|_{x_1} = 0 \).

OR

Q2(b)' The enthalpy of a binary liquid system of species 1 and 2 at fixed temperature and pressure is represented by the equation:

\[
H = 400x_1 + 600x_2 + 8x_1 x_2 (40x_1 + 20x_2)
\]

Where \( H \) is in J mol\(^{-1}\). Determine expressions for \( T_1 \) and \( P_2 \) as function of \( x_1 \).

Q3(a) Define Bubble Point, Dew Point and Tie Line. Draw a typical \( T-x-y \) and \( P-x-y \) diagram and show sub cooled liquid, superheated vapors and Liquid-Vapor mixture regions, dew point curve, bubble point curve, boiling points of pure components, and vapors pressure of pure substances on it.

Q3(b) Plot \( P-x-y \) data for a binary system at a temperature at which \( P_1 \) = 84.562 kPa, and \( P_2 \) = 19.953 kPa. Assume system to follow Raoult's Law. (Determine \( P \) and \( y \) values for \( x_1 = 0.2, 0.4, 0.6 \), and 0.8).

Q4(a) Drive the relation of equilibrium constant to composition for liquid phase reaction. Modify this relation for the equilibrium mixture behaving as an ideal solution.

Q4(b) The reaction \( \text{N}_2 + \text{O}_2 \rightarrow 2\text{NO} \) takes place in the gas phase at 2700°C and 2025 kPa. The reaction mixture initially comprises 15 mole% oxygen, 77 mole% nitrogen and rest inert. The standard Gibb's free energy change for reaction is 113.81 kJ/mol at this temperature. Assuming ideal gas behaviour, calculate partial pressures of all species at equilibrium.

OR

Q4(b)' For the ammonia synthesis reaction written:

\[
\frac{1}{2} \text{N}_2(g) + 3/2 \text{H}_2(g) \rightarrow \text{NH}_3(g)
\]

With 0.5 mol \( \text{N}_2 \) and 1.5 mol \( \text{H}_2 \) as the initial amounts of reactants and with the assumption that the equilibrium mixture is an ideal gas show that \( e = \frac{1}{\left(1+1.299 \frac{K}{P}b^2\right)^{1/2}} \).