### 2012-13

**B.TECH. Second Year (IV Semester) EXAMINATION**

**Chemical Engineering**

**Engineering Chemistry**

(AC-204)

**Maximum Marks: 60**

**Credits: 03**

**Duration: Three Hours**

---

**Answer all the questions.**

**Assume suitable data if missing.**

**Notations used have their usual meaning.**

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Derive Henderson-Hasselbalch equation. Discuss its significance.</td>
<td>[06]</td>
</tr>
<tr>
<td>1(b)</td>
<td>What is meant by buffer solution? Explain why a solution of weak acid and its salt with strong base behaves as buffer solution.</td>
<td>[04]</td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1'</td>
<td>Write short notes on any FOUR of the following:</td>
<td>[10]</td>
</tr>
<tr>
<td>(a)</td>
<td>Transport number.</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>Polyprotic acid.</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Buffer capacity.</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>Amphoteric salts.</td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>Electrical conductance.</td>
<td></td>
</tr>
</tbody>
</table>

| 2(a)   | Distinguish between any TWO of the following:                           | [05] |
|        | (i) Precision and accuracy.                                             |      |
|        | (ii) Determinate error and indeterminate error.                         |      |
|        | (iii) Relative error and absolute error.                                |      |
| 2(b)   | Discuss the principle and procedure of ion exchange chromatography.     | [05] |

---

Contd. ....... 2
3(a) Describe the mechanism of electrophilic addition of halogen acid to an unsymmetrical alkene.
(b) What is nucleophilic substitution reaction? Giving suitable example discuss the mechanism of $S_N^2$ reaction.

4. Explain any FOUR of the following:
   (a) Specific rotation.
   (b) Diastereomers.
   (c) Racemic modification.
   (d) Chirality.
   (e) Centre of symmetry and plane of symmetry.

5(a) Mention the different methods used for the determination of molecular weight of macromolecules. Describe one method in detail.
(b) Discuss the electrical properties of sols.

6(a) Write the assumptions of Langmuir adsorption isotherm and also derive its mathematical equation.
(b) Discuss the applications of adsorption.
2012-13
B.TECH. (IV SEMESTER) EXAMINATION
(Chemical Engineering)
Engineering Chemistry & Material Science
(AC-211)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
all questions carry equal marks.

Q. No. 1
(a) Discuss the Bronsted-Lawry concept of acids and bases. Describe its advantages over Arrhenius concept. [5]
(b) Define the term transport number. Give the detail of an experimental method for the determination of transport number of Ag⁺ and NO₃⁻ ions. [5]

OR

1 (b) What is transport number of an anion? Obtain the relationship between the ionic mobility and transport number.

2. Write notes on any four of the following: [10]
   (a) Enantiomerism
   (b) Diastereomers
   (c) Sequence rules for assigning R & S configuration to an optically active compounds
   (d) Polarimeter
   (e) Racemic modification

3. What are stainless steels? How are they classified? Give the general composition, properties and uses of different types of stainless steels. [10]

OR

3 (b) What are cast irons? How are they classified? Give the composition, properties and uses [10]

Contd. ...... 2
of unalloyed gray cast iron and malleable cast iron.

4. Draw phase equilibrium diagram of Fe-C system. Describe the solid phases and invariant reactions in the phase diagram.

5. Draw the heat treating temperatures for carbon steel. Describe the process of normalizing and tempering.

OR

5'. Draw T.T.T. diagram for eutectoid steel and describe its salient points. List the different changes occurring in steel structure below lower critical temperature.

6.(a) What is meant by 'space lattice' of a crystal? Draw a unit cell for space lattices of the following types:

   (i) Simple-cubic; (ii) Face-centred cubic; (iii) Body-centred cubic

(b) What is meant by crystal imperfections? State the effect of imperfections on the properties of materials?
1. (a) Prove that 
\[ \text{Curl} \ (\mathbf{u} \times \mathbf{v}) = \mathbf{v} \cdot \nabla \mathbf{u} - \mathbf{u} \cdot \nabla \mathbf{v} + \nabla \cdot \nabla \mathbf{v} - \nabla \cdot \nabla \mathbf{u} \]

OR

(a') Prove that 
\[ \text{div}(\mathbf{u} \times \mathbf{v}) = \mathbf{v} \cdot \text{curl} \mathbf{u} - \mathbf{u} \cdot \text{curl} \mathbf{v}. \]

Hence prove that if \( \mathbf{A} \) and \( \mathbf{B} \) are irrotational then \( \mathbf{A} \times \mathbf{B} \) is solenoidal.

(b) Fluid motion is given by 
\[ \mathbf{V} = ax\mathbf{i} + ay\mathbf{j} - 2az\mathbf{k}. \]

(i) Is it possible to find out the velocity potential? If so, find it.

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

(c) Find the values of \( a, b, c \) so that the directional derivative of 
\[ \phi = axy^2 + byz + cx^2z^3 \]

at \((1, 2, -1)\) has maximum magnitude 64 in the direction parallel to \( z \)-axis.

2. (a) Verify the divergence theorem for \( \mathbf{A} = 4xi - 2y^2j + z^2k \) taken over the region bounded by \( x^2 + y^2 = 4, z = 0 \) and \( z = 3 \).

(b) Verify Green's theorem in the plane for 
\[ \int_c \left[ (x^3 - x^2y)dx + xy^2 \right] \] 
where \( c \) is the boundary of the region enclosed by the circles \( x^2 + y^2 = 4 \) and \( x^2 + y^2 = 16 \).

OR

(b') Verify Stoke's theorem for 
\( \mathbf{F} = (2x - y)\mathbf{i} - yz^2 \mathbf{j} - y^2z \mathbf{k} \) where \( S \) is the upper half of the sphere \( x^2 + y^2 + z^2 = 1 \) and \( C \) is its boundary.

3. (a) (i) Find the Laplace transform of 
\[ \frac{1 - \cos t}{t^2} \]

OR

(a') Find the inverse Laplace transform of 
\[ \frac{s}{(s^2 + a^2)(s^2 + b^2)} \] using convolution theorem, \( a, b \) being constants.

Contd.....
(ii) Find the inverse Laplace transform of \( \cot^1 \left( \frac{s}{k} \right) \), where \( k \) is a constant.

(b) Find the Laplace transform of the triangular wave represented in the figure below:

OR

(b') An alternating e.m.f. \( E \sin \omega t \) is applied to an inductance \( L \) and a capacitance \( C \) in series. Use Laplace transform method to show that the current in the circuit is

\[
\frac{E}{L \left( R^2 - n^2 \right)} \left( \cos \omega t - \cos nt \right), \quad n^2 = \frac{1}{LC}.
\]

(c) (i) Using Laplace transform method, solve the differential equation

\[ y''(t) + 2y(t) = 18t \text{ given that } y(0) = 0 = y \left( \frac{\pi}{2} \right). \]

(ii) Using Laplace transform method solve the integral equation

\[ y + \int_0^t y \, dt = 1 - e^{-t}. \]

4. (a) The points of trisection of a string are pulled aside through a distance \( b \) on opposite sides of the position of equilibrium, and the string is released from rest. Find an expression for the displacement of the string at any subsequent time and show that the mid-point of the string always remains at rest.

OR

(a') The equation for the conduction of heat along a bar of length \( t \) is

\[
\frac{\partial u}{\partial t} = \alpha^2 \frac{\partial^2 u}{\partial x^2},
\]

neglecting radiation. Find an expression for \( u \), if the ends of the bar are maintained at zero temperature and if, initially, the temperature is \( t \) at the centre of the bar and falls uniformly to zero at its ends.

(b) Find the particular solution of the Laplace equation \( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0 \) by the method of separation of variables.
1. (a) Define fluid. Give a detailed classification of fluid based on their rheological behaviour. (08)

1. (b) Define shear stress and rate of strain tensor. Show that the rate of deformation of a fluid under the action of shear force equals to the velocity gradient. (04)

2. (a) A spherical balloon, of diameter 1.5 m and total mass 1.2 kg, is released in the atmosphere. Assuming that the balloon does not expand and that the temperature lapse rate in the atmosphere is 0.0065 K m\(^{-1}\), determine the height above sea-level to which the balloon will rise. Atmospheric temperature and pressure at sea-level are 15 °C and 101 kPa respectively; for air, \(R = 287 \text{ } \text{J} \text{ kg}^{-1} \text{ K}^{-1}\). Derive the equations used.

OR

(a') State Archimedes Principle. Discuss in detail the stability of Submerged body and Floating body in fluid. For the float as given below, find the specific gravity of the oil.

2. (b) Derive the equations for simple, inverted, and inclined U-tube manometers. (04)
3. (a) Obtain the expression for stream function and velocity potential for source, sink, doublet and uniform flow.

OR

(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

(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) Flow through a heat exchanger tube is to be studied by means of a $\frac{1}{3}$ scale model. If the heat exchanger normally carries water, determine the ratio of pressure losses between the model and prototype if:

(i) Water is used in the model.

(ii) Air at normal temperature and pressure is used in the model.

$\mu_{air} = 1.8 \times 10^{-5}$ kg m$^{-1}$ s$^{-1}$, $\mu_{water} = 1.0 \times 10^{-5}$ kg m$^{-1}$ s$^{-1}$, $\rho_{air} = 1.23$ kg m$^{-3}$, $\rho_{water} = 1000$ kg m$^{-3}$.

OR

(a') Discuss the various similarity laws in modeling a fluid flow system. Also explain the significance of various dimensionless numbers encountered in similitude study.

4. (b) For flow in regular-helical tube coils, pressure drop, $\Delta P$, as a dependent variable, depends on the independent variables of the fluid properties ($\rho$ and $\mu$), the flow rate variable ($V$) i.e., velocity, and the parameters of the coil geometry ($d$, $D$, $p$, $L$). Perform dimensional analysis on these variables using Rayleigh's theorem to obtain the dimensionless form of the functional relationship. Explain the significance of each of the dimensionless groups thus formed.

5. (a) A horizontal venturimeter with a discharge coefficient of 0.96 is to be used to measure the flow rate of water up to 0.025 m$^3$/s in a pipeline of internal diameter 100 mm. The meter is connected to a differential manometer containing mercury of specific gravity 13.6. If the maximum allowable difference in mercury levels is 80 cm, determine the diameter of the throat. Derive the expressions used.

5. (b) 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.
2012 – 2013
B.TECH. WINTER (IV SEMESTER) EXAMINATION
(CHEMICAL ENGINEERING)
MATERIAL SCIENCE AND ENGINEERING MATERIALS
(CH – 223)
Credits: 04
Maximum Marks: 60
Duration: Three Hours

Note: Answer ALL the questions.

1. (a) Differentiate between:
   (i) Interstitial and substitution solid solution.
   (ii) Frenkel and Schottky defect.
   (iii) Packing factor and coordination number.

(b) What do you mean by ligancy of an ionic crystal? Write down the range of
    radius ratio for different possible ligancy and the corresponding configuration.

(c) Express the edge, face diagonal and body diagonal of the unit cell in terms of
    the atomic radius ‘r’ for SC, FCC and BCC crystal respectively. Also, write
    their coordination numbers.

OR

(c') Draw a unit cell of Diamond cubic crystal showing the position of carbon
    atoms in it. Write down its coordination numbers. Also, calculate its packing
    factor.

2. (a) State Hume-Rothery’s condition of complete miscibility for solid solution.
    Draw a phase diagram of a system which satisfies Hume-Rothery’s condition.
    Write down its important features and apply phase rule to various regions of
    the diagram.

OR

(a') Define heat treatment of steel. Discuss the formation of coarse pearlite, fine
    pearlite and Bainite with the help of TTT diagram for austenite to pearlite
    transformation in steel.

(b) Draw a pressure – temperature diagram for one component system of Iron.
    Apply phase rule to this system and find out degrees of freedom at different
    regions of the phase diagram. Also write the salient features of diagram in
    brief.

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

Contd....2
(b) Give reasons for the following: [1+2+2+1]

(i) Production of high carbon steels is mostly as bars and forgings.

(ii) The Carbon in Grey Cast Iron is present in the form of graphite while in white Cast Iron it is present as Cementite.

(iii) For operations involving hydrogen at high pressure alloy steel reactors are advantageous over carbon steel.

(iv) Alloy steels containing copper are more durable than mild steel.

OR

(b') What is a Cast Iron? What are the factors determining the properties of Cast Iron. Discuss the properties and uses of Grey, White, Malleable and Nodular Cast Iron. [06]

(c) Discuss the effect of following elements on Carbon steel: Carbon, phosphorus, sulphur, manganese and silicon. [05]

4. (a) What are glasses and how are they classified? Write down the composition, properties and uses of soda-lime glass. [05]

(b) Write short note on any TWO of the following: [5+5]

(i) Mechanism of oxidation corrosion and oxidation rate laws.

(ii) Factors affecting the rate of corrosion.

(iii) Classification of composite materials.

(iv) Polymer additives.
2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
PROCESS INSTRUMENTATION
CH-224

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.

1(a) Define measuring instrument. Also with the help of block diagram discuss different elements of measuring equipment.

1(b) What are the general classifications of measuring instruments? Explain any three briefly.

1(c) Using a general relation between input and output value, define zero, first, and second order system.

OR

1(e) What do you understand by static characteristics of an instrument? List them and discuss any five of them in detail.

2(a) What do you mean by analogue signal filtering? Classify them according to their applications.

2(b) To amplify small differential pressure signals acted against a silicon diaphragm, which amplifier you would like to prefer and why?

2(c) Define sensing elements used in measuring instruments? To measure or sense the displacement, what type of sensors may be applied? Discuss at least two examples briefly.

OR

2(e') Explain various recording instruments used in industries.

3(a) Enumerate various temperature measurement devices. Also explain the working principle of optical pyrometer. Why optical pyrometer is considered more accurate than radiation pyrometer?

OR

3(a') Classify flow measuring instruments. Explain any one of them in detail, and also state the principle on which it works.

3(b) Specify at least three methods for determining viscosity in process industry. Explain drag type viscometer with the help of neat diagram.

Contd………2
3(c) (i) Why radar method is considered more accurate than ultrasonic method of level measurement?
(ii) What are the conditions where spiral or helical bourdon tubes are applied?
(iii) State the working principle of vibration sensor used in density measuring devices.
(iv) List various humidity measuring devices.
(v) Describe the difference in sensor and transducer.

4(a) Discuss various methods used to analyse solid / liquid / gas composition. Describe construction and working mechanism of a spectrophotometer which can be used for UV as well as visible region both.

OR

4(a') What do you understand by biosensors? List various sensing elements used for biosensors and discuss any three of them in detail. List various applications of biosensors.

4(b) A lab worker is trying to calibrate a new calorimeter for a type of green dye. He found that a 2.00 ppt solution transmits 85.7% of the incident light, a 6.00 ppt solution transmits 63.0%, and a 10.00 ppt solution transmits 46.3%. Determine the absorbance of each of these standard solutions.

4(c) Identify following P & ID element:
(i) I (subsequent letter)
(ii) A (subsequent letter)
(iii) W (first letter)
(iv) V (first letter)
(v) 
(vi) 
(vii) 
(viii) 
(ix) 
(x)
2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
ENGINEERING BIOLOGY
CH-225

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Start each question from new page.
Notations used have their usual meaning.

Q. 1(a) What is Engineering Biology and how does it differ from other fields of science? [06]

1(b) Write in brief about Prokaryotic cells with the help of a neat figure. [05]

1(c) Give the nutritional requirements of biological system. [04]

OR

1'(c) What is the role of Golgi bodies and Endoplasmic Reticulum in Eukaryotic cells? [04]

Q. 2(a) Explain briefly about Lipids and also give its functions. [05]

2(b) What do you understand by Proteins? Write its classification on the basis of shape and functions? [07]

OR

2'(b) What are Immunoglobulins? Explain it with the help of neat figure and also write its major classes. [07]

2(c) Write a short note on Cholesterol. [03]

Q. 3(a) Explain and draw the structure of DNA. Also show the arrangement of various constituents of DNA duplex. [07]

3(b) Define any two of the following:
(i) Sense and Antisense Strands [04]

Contd......
(ii) Ribosomal RNA
(iii) Genetic Code

3 (e) Differentiate between Deoxyribo nucleic acid and Ribonucleic acid. [04]

OR

Q. 3'(a) Briefly discuss the characteristics features of Genetic Code. [04]

3'(b) Write the steps involved in PCR technology. Also give its important applications. [07]

3'(c) What is the significance of Recombinant DNA? [04]

Q. 4(a) Glucose is converted to fructose by glucose isomerase, the slow product formation step is reversible as given below:

\[
S + E \xrightleftharpoons[k_2]{k_1} E \cdot S
\]

\[
E \cdot S \xrightleftharpoons[k_4]{k_3} P + E
\]

Derive the rate equation by employing the Michaelis-Menten approach. [08]

4 (b) Write the applications of microorganisms in Agriculture and Medical field. [04]

4 (c) How can you classify commercially produced Enzymes? [03]
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     The rate of fluid flow down a sloping channel of rectangular cross section is given     [15]
      by the equation:
      \[ Q = \frac{S}{2} \left( RH \right)^{3/2} \left( B + 2D \right)^{2/3} \]
      Where:
      \[ Q = \text{Flow Rate} \ (\text{m}^3/\text{s}) \]
      \[ B = \text{Channel Width} \ (20 \text{m}) \]
      \[ H = \text{Depth of Flow} \]
      \[ S = \text{Slope Gradient} \ (0.0002) \]
      \[ n = \text{Roughness} \ (0.03) \]
      An Engineer has estimated that the depth of flow must lie in the range 0.6 < H < 0.9 m
      Use a suitable Method to Estimate the actual depth of flow.

OR

1'    Solve the following system of equations
      \[ 5X_1 - 2X_2 + X_3 = 4 \]
      \[ 7X_1 + X_2 - 5X_3 = 8 \]
      \[ 3X_1 + 7X_2 + 4X_3 = 10 \]
      By LU decomposition Method

2     Find the Solution of the following System of equations
      \[ 83X_1 + 11X_2 - 4X_3 = 95 \]
      \[ 7X_1 + 52X_2 + 13X_3 = 104 \]
      \[ 3X_1 + 8X_2 + 29X_3 = 71 \]
      Use Jacobi's method for first four iterations.
3. Bacteria grows exponentially according to the following relation
\[ N = N_0 e^{kt} \]

An experiment records the history of growth as follows:

<table>
<thead>
<tr>
<th>t(sec)</th>
<th>0.5</th>
<th>1.0</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>50</td>
<td>75</td>
<td>200</td>
<td>300</td>
<td>450</td>
</tr>
</tbody>
</table>

Use the method of least square to find the constant \( N_0 \) and \( k \).

3'. From the following table of values, evaluate \( f(x) \).

\[
\begin{array}{c|cccc}
 x & 10 & 20 & 30 & 40 & 50 \\
 Y = f(x) & 45 & 66 & 81 & 93 & 101 \\
\end{array}
\]

4(a) Solve the following differential equation
\[ \frac{dy}{dx} = x + y \]
with the initial condition \( y(0) = 1 \), using fourth order Runge-Kutta method from \( x = 0 \) to \( x = 0.4 \) taking \( h = 0.2 \).

4(b) Consider the following system of simultaneous differential equation
\[
\begin{align*}
\frac{dy}{dx} &= f(x, y, z) \\
\frac{dz}{dx} &= g(x, y, z)
\end{align*}
\]
with the initial condition \( y(x_0) = y_0 \) and \( g(x_0) = g_0 \).

Explain the step by step second order Runge-Kutta method for solving the above equations.
2012 – 2013
B. TECH. WINTER (IV SEMESTER) EXAMINATION
(ELECT./CHEMICAL/MECH./PETRO-CHEMICAL ENGINEERING)
COMMUNICATION SKILLS
(HU - 202)
CREDITS – 04
Max. Marks: 40
Duration: Three Hours

Note: Answer all questions.

UNIT – I

1. You bought a laptop from DELL VISION, ALIGARH with a warranty of two years. After six months you discover that the screen gets blurred every now and then and the sound system is also giving trouble. Write a letter to the dealer complaining about the problem and requesting him to get the defects repaired or replace it.

OK

Write a job application and create your CV in response to the following advertisement:

THE HINDU
May 10, 2013
THE GULF ENGINEERING SERVICES
19, K.G. Marg, New Delhi

Applications are invited from all branches of fresh engineering graduates to work in different projects such as Metro Rail, Oil Fields etc in Saudi Arabia. Apply with a detailed CV.

Excellent communication skills in English is a must. Working knowledge of Arabic will be an added advantage. Those who do not have a valid passport need not apply.

Last Date: May 30, 2013

UNIT – II

2. Define and draft any one of the following business messages assuming an appropriate business situation.
(a) Telx
(b) Memo
(c) e-mail

UNIT – III

3. Make note or write an abstract of the following passage:

- The Scandinavian countries are much admired all over the world for their enlightened social policies. Sweden has evolved an excellent system for protecting the individual citizen from high-handed or incompetent public officers. The system has worked so well that it has been adopted in other countries like Denmark, Norway, Finland and New Zealand. Even countries with large populations are now seriously considering imitating the Swedes.

Contd…..2,
The Swedes were the first to recognize that public officials like civil servants, police officers, health inspectors or tax collectors can make mistakes or act over-zealously in the belief that they are serving the public. As long ago as 1809, the Swedish Parliament introduced a scheme to safeguard the interest of the individual. A parliamentary committee representing all political parties appoints a person who is suitably qualified to investigate private grievances against the State. The official title of the person is 'Justitieombudsmann', but Swedes commonly refer to him as the 'J.O.' or 'Ombudsman'.

The Ombudsman is not subject to political pressure. He investigates complaints large and small that come to him from all levels of society. As complaints must be made in writing, the Ombudsman receives an average of 1200 letters a year. He has eight lawyer assistants to help him, and he examines every single letter in detail. There is nothing secretive about the Ombudsman's work, for his correspondence is open to public inspection. If a citizen's complaint is justified, the Ombudsman will act on his behalf. The action he takes varies according to the nature of the complaint. He may gently reprimand an official or even suggest to Parliament that a law be altered. The following case is a typical example of the Ombudsman's work.

A foreigner living in a Swedish village wrote to the Ombudsman complaining that he had been ill-treated by the police, simply because he was a foreigner. The Ombudsman immediately wrote to the Chief of Police in the district asking him to send a record of the case. There was nothing in the record to show that the foreigner's complaint was justified and the Chief of Police stoutly denied the accusation. It was impossible for the Ombudsman to take action on the complaint, but when he received a similar complaint from another foreigner in the same village, he immediately sent one of his lawyers to investigate. The lawyer ascertained that a policeman had indeed dealt roughly with foreigners on several occasions. The fact that the policeman was prejudiced against foreigners could not be recorded in the official files. It was only possible for the Ombudsman to find this out by sending one of his representatives to check the facts on the spot. The policeman in question was severely reprimanded and was informed that if any further complaints were received against him, he would be prosecuted. The Ombudsman's prompt action in the matter at once put an end to an unpleasant practice which might have gone unnoticed.

UNIT - IV

4. Generate a group discussion choosing one of the following topics with at least four participants.
   (a) The changing value system - a need for re-orientation
   (b) The future of information technology
   (c) Increasing crime against women in India: Causes and ways to curb.

UNIT - V

5. Write the transcript of a telephonic conversation you had with the receptionist of a Guest House in Bangalore to book a room for three days as you are going there to attend a seminar.

OR

Reproduce the transcript of a job interview you have attended recently with three interviewers as a fresher.
2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
MECHANICS OF SOLIDS
MN-210

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  At a point in a material the stresses are
\[ \sigma_{xx} = 37.2\, MN / m^2, \sigma_{yy} = 78.4\, MN / m^2, \sigma_{zz} = 149\, MN / m^2, \]
\[ \sigma_{xy} = 68.0\, MN / m^2, \sigma_{yz} = -18.1\, MN / m^2, \sigma_{zx} = 32.0\, MN / m^2. \]
Calculate the shear stress on a plane whose normal makes an angle of 48° with the x-axis and 71° with the y-axis.

OR

1' The stress tensor for a three dimensional stress system is given below. Determine the magnitudes of the three principal stresses and determine the Eigen vectors of the major principal stress.

\[
\begin{pmatrix}
80 & 15 & 10 \\
15 & 0 & 25 \\
10 & 25 & 0
\end{pmatrix}
\text{MN / m}^2
\]

2(a) A grinder wheel has external and internal diameters as 300mm and 25mm respectively. If the thickness of the wheel at the outer radius is 25mm, what should be the thickness at the inner radius for a uniform allowable stress of 10 MPa at 2800 rpm? Take density of the wheel material as 2700 kg/m³.

2(b) Derive the relationship between the Bulk Modulus 'K', Young's Modulus 'E' and Poisson's ratio 'ν'.

OR

Contd......2
2(b') Derive the expression for thickness of a disc of uniform strength. [06]

3(a) A thick cylinder of 100 mm internal radius and 150 mm external radius is subjected to an internal pressure of 60 MN/m² and an external pressure of 30 MN/m². Determine the hoop and radial stresses at the inside and outside of the cylinder together with the longitudinal stress if the cylinder is assumed to have closed ends. [06]

3(b) Derive the expression for the change in internal volume of thin cylinders subjected to internal pressure. If a fluid is used as the pressurisation medium, what will be the extra amount of fluid which must be pumped into the cylinder in order to raise the pressure by a specified amount, the cylinder being initially full of fluid at atmospheric pressure? [06]

4 A beam of uniform section with rigidly fixed ends which are at the same level has an effective span of 10 m. It carries loads of 30 kN and 50 kN at 3 m and 6 m respectively from the left hand end. Find the vertical reactions and the fixing moments at each end of the beam. Determine the bending moments at the two points of loading and sketch, approximately to scale, the Bending Moment diagram for the beam. [12]

OR

4' State Clapeyron's theorem of three moments. Derive the full three moment equation and thus simplify it for a uniform beam with the supports on the same level. [12]

5(a) State and prove Castigliano's first theorem. [06]

5(b) Define Resilience. Derive the expression for resilience in a hollow shaft subjected to a twisting moment. [06]
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. | Question                                                                 | M.M. |
--- | --- | --- |
1(a) | What is a Carnot Engine? Why thermal efficiency of 100% is not possible for heat engine? | [04] |
1(b) | One mole of an ideal gas at P1 and T1 is compressed reversibly and adiabatically to a pressure of P2 and then it is cooled at constant volume till the pressure reduces to P1. Finally energy is transferred as heat at constant pressure till the gas is restored to T1. Show that the net work done is given by $$ RT_1 \left[ 1 - \frac{(P_2/P_1)^{\frac{y-1}{y}}}{y-1} + 1 - \frac{(P_2/P_1)^{\frac{1}{y}}}{} \right] $$ | [05] |
1(c) | One mole of an ideal gas, $C_p = (7/2)R$ and $C_v = (5/2)R$, is compressed adiabatically in a piston cylinder device from 2 bar and 298.15 K (25°C) to 7 bar. The process is irreversible and requires 35% more work than a reversible, adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas? OR
1'I(a) | Differentiate between a reversible and quasi static process. | [03] |
1(b) Prove that Entropy is not a path function but a state function by taking example of an ideal gas going from state 1 at P1, T1, V1 to state 2 at P2, T2, V2 by two different reversible paths.

1(c) During the suction stroke in a Diesel engine, atmospheric air at 300K and 0.1 MPa is drawn into the engine cylinder and then it is compressed reversibly and adiabatically till the volume of air reduces to 1/15 of the original volume. At the end of the compression stroke the temperature of the air is such that when fuel is injected it ignites immediately. Calculate the temperature and pressure of the air at the end of the compression stroke. Also calculate the work done per mole of the air. (Assume γ = 1.4 for air).

2(a) Differentiate between Vapour compression refrigeration and absorption refrigeration cycle with the help of their line diagram.

2(b) The excess Gibbs energy for the system chloroform (1)/ethanol (2) at 328.15 K is well represented by the equation, written

\[ \frac{G^E}{RT} = (1.42x_1 + 0.59x_2)x_1x_2 \]

The vapour pressures of chloroform and ethanol at 328.15 K are

\[ P_1^* = 82.37 \text{ kPa}, \quad P_2^* = 37.31 \text{ kPa} \]

Assuming the validity of modified Raoult's law, make BUBL P calculations at 328.15 K for liquid mole fractions \( x_1 \) of 0.25.

3(a) At 30°C and 1 atm, the volumetric data for a liquid mixture of benzene (b) and cyclohexane (c) are represented by the equation

\[ V(\text{cm}^3/\text{g mol}) = 109.4 - 16.8x_b - 2.64x_b^2 \]

Where \( x_b \) is the mole fraction of benzene. Find an expression for the partial molar volumes of the two components \( V_b \) and \( V_c \).
3(b) Differentiate between excess and residual property and show that for an ideal gas fugacity coefficient \( \Phi_i = 1 \).

3(c) 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.

3(c') State Lewis Randall rule and show that the fugacity coefficient of species \( i \) in an ideal solution is equal to fugacity coefficient of pure species \( i \) in the same physical state as the solution and at the same temperature and pressure.

4(a) What is standard Gibb's free energy change of a chemical reaction? Prove that standard Gibb's free energy change is related to the equilibrium constant by the relation:

\[
\ln K = -\Delta G^*/RT
\]

4(b) The reaction \( \text{N}_2 + \text{O}_2 \rightarrow 2\text{NO} \) takes place in the gas phase at 2700\(^\circ\)C and 2025kPa. The reaction mixture initially comprises 15mole\% oxygen, 77mole\% nitrogen and rest inert. The standard Gibb's free energy change for reaction is 113.83kJ/mol at this temperature. Assuming ideal gas behaviour, calculate partial pressures of all species at equilibrium.

OR

4(c) In a laboratory investigation, acetylene is catalytically hydrogenated to ethylene at 1393.15 K and 1 bar. If the feed is an equimolar mixture of acetylene and hydrogen, what is the composition of the product stream at equilibrium? [Graph of \( \ln K \) vs \( 10^4/T \) attached].

[Figure Enclosed]