2012 – 2013
B. TECH. (IV SEMESTER) EXAMINATION
(PETROCHEMICAL ENGINEERING)
APPLIED NUMERICAL METHODS
(AM - 242)
CREDITS – 04

Max. Marks: 60

Note: (i) Answer all questions.
       (ii) Programmable Calculator is not allowed.

1. (a) A sphere of density \( p \) and radius \( r \) sinks in water to a depth \( x \) given by
       \[ x^3 - 3xy^2 + 4y^3p = 0. \]
       Solve this equation by general iteration method correct to
       three decimals for \( y = 1, \ p = 0.72 \).

       OR

       (a') Determine \( p, q \) and \( r \) so that the order of iterative method:
       \[ X_{n+1} = pX_n + \frac{qa}{X_n} + \frac{r}{X_n} \]
       for \( \sqrt[3]{a} \) becomes as high as possible.

(b) Establish the formula \( X_{n+1} = \frac{1}{2} \left( x_n + \frac{N}{x_n} \right) \) and use it to compute the value of \( \sqrt{2} \)
    correct to four decimal places.

(c) Solve the following system of linear equations by Gauss-elimination method:
    \[
    \begin{align*}
    2x + 2y + z + 2u &= 7, \\
    x - 2y - u &= 2, \\
    3x - y - 7z - u &= 3, \\
    x - 2u &= 0
    \end{align*}
    \]

3. (a) The following table gives the angular displacement \( \theta \) (radians) at different intervals of time \( t \) (seconds):

\[
\begin{align*}
\theta &: 0.052 \quad 0.105 \quad 0.158 \quad 0.242 \quad 0.327 \quad 0.408 \quad 0.489 \\
t &: 0 \quad 0.02 \quad 0.04 \quad 0.06 \quad 0.08 \quad 0.10 \quad 0.12
\end{align*}
\]

Calculate the angular velocity at the instant \( t = 0.02 \).
(b) Using the following table find \( \frac{dy}{dx} \) and \( \frac{d^2y}{dx^2} \) at \( x = 3 \).

\[
\begin{array}{cccccc}
  x & 0 & 2 & 3 & 4 & 7 \\
  y = f(x) & 4 & 26 & 58 & 112 & 466 \\
\end{array}
\]

(c) Derive the Simpson's \( \frac{1}{3} \) rule from the general quadrature formula and use it to evaluate the integral \( \int_0^1 \frac{dx}{1 + x} \) with \( h = 0.125 \). OR

(c') Find the quadrature formula

\[
\int_0^1 e^{-x} f(x) \, dx = \lambda_0 f(x_0) + \lambda_1 f(x_1)
\]

Which is exact for polynomial of highest possible degree? Then use the formula to evaluate

\[
\int_0^1 \frac{dx}{(x^2 + 2x + 2)}
\]

4. (a) Using modified Euler's method, find the value of \( y \) when \( x = 1.2 \) given that \( \frac{dy}{dx} = \sqrt{xy} \), \( y(1) = 1 \).

Take \( h = 0.1 \). OR

(a') Use Taylor's series method to find a series expansion upto \( x^3 \) for the initial value problem.

\[
\frac{dy}{dx} = y \sin x + \cos x, \quad y(0) = 0.
\]

(b) Apply fourth order Runge-Kutta method to find \( y(0.2) \), given that \( \frac{dy}{dx} = x^2 + y, \quad y(0) = 1 \) and \( h = 0.1 \).

(c) Solve the boundary value problem

\[
y'' - 64y + 10 = 0
\]

With \( y(0) = y(1) = 0 \) and \( h = \frac{1}{4} \) by finite difference method.
2012 - 2013
B. TECH. WINTER (IV SEMESTER) EXAMINATION
(ELECT./CHEMICAL/MECH./PETRO-CHEMICAL ENGINEERING)
COMMUNICATION SKILLS
(FU - 202)
CREDITS: 04

Max. Marks: 40

Note: Answer all questions.

Duration: Three Hours

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.

OR

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

THE HINDU

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) Telex
(b) Memo
(c) e-mail

UNIT - III

3. Make notes 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.
Q.No. 1

(a) What is a Carnot Engine? Why thermal efficiency of 100% is not possible for heat engine? [04]

(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

\[ W = RT_1 \left[ 1 - \frac{(P_2/P_1)^{(\gamma-1)/\gamma}}{\gamma - 1} + 1 - \frac{(P_2/P_1)^{-1}}{\gamma} \right] \]

[05]

(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? [06]

OR

1'(a) Differentiate between a reversible and quasi static process. [03]

Contd........2
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 $P_1, T_1, V_1$ to state 2 at $P_2, T_2, V_2$ by two different reversible paths.

1(c) During the suction stroke in a Diesel engine, atmospheric air at 300K and 0.1MPa 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 $\gamma = 1.4$ 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

$$G^E_{\text{ex}} = \frac{(1.42x_1 + 0.59x_2)}{x_1x_2} \frac{RT}{x_1^2}$$

The vapour pressures of chloroform and ethanol at 328.15 K are

$$P_1^v = 32.37 \text{ kPa}, \quad P_2^v = 37.31 \text{ kPa}$$

Assuming the validity of modified Raoult's law, make BUBI 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 (1) and Cyclo-benzene (2) are represented by the equation

$$V(\text{cm}^3/\text{g-mol}) = 109.4 - 16.8x_1 - 2.64x_1^2$$

Where $x_1$ is the mole fraction of benzene. Find an expression for the partial molar volume of the two components $V_1$ and $V_2$.

Contd......
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.

OR

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 Gibbs's free energy change of a chemical reaction? Prove that standard Gibbs's free energy change is related to the equilibrium constant by the relation:

\[ \ln K = -\frac{\Delta G^0}{RT} \]

4(b) The reaction \( \text{N}_2 + \text{O}_2 \rightarrow 2\text{NO} \) takes place in the gas phase at 2700°C and 2025kPa. The reaction mixture initially comprises 15 mole% oxygen, 77 mole% nitrogen and rest inert. The standard Gibbs'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(b') 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]
Fig. Graph of $\ln K$ vs $10^4/T$
1. (a) Describe and develop a suitable process flow sheet for the manufacture of methanol from synthesis gas, or the manufacture of ethylene glycol with special reference to various types of processes available, effect of operating parameters on yield and reactions. [10]

(b) Explain the base scheme employed in the manufacture of methanol using partial oxidation or steam reforming technique/method. [05]

2. (a) Explain the various processes available for the manufacture of vinyl chloride monomer with reference to reactions involved and the merits and demerits. [07]

(b) Explain the various processes available for the manufacture of maleic anhydride and phthalic anhydride with reference to chemical reactions involved and the merits and demerits of the processes. [08]

(b') Describe and develop a suitable process flow sheet for the manufacture of maleic anhydride or styrene with reference to reactions involved and the effect of operating parameters. [08]

3. (a) List the various industrial methods/processes employed for the manufacture of acetone and linear alkyl benzene (LAB). [06]

(b) Explain the effect temperature and pressure on the conversion of isopropanol to acetone. [02]

(c) Explain the role of steam in the manufacture of acetone using the dehydrogenation of isopropanol process. [01]

(d) Develop a suitable process flow sheet for the manufacture of acetone or linear alkyl benzene with reference to the chemical reaction(s) involved and consumption pattern. [06]

4. (a) Describe the manufacture DMT with the help of a process flow sheet with reference to chemical reactions. Explain the problems associated in the development of teraphthalic acid. [09]

(b) List the chemical reactions involved, catalyst and the operating conditions in the manufacture of acrylic acid. [04]

(c) List the various feedstocks employed in the polyester synthesis. [02]
<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Discuss various theories of origin of Petroleum.</td>
<td>[05]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Mention various types of oil bearing rocks that are important for oil generation and production. Discuss any one of them in detail.</td>
<td>[10]</td>
</tr>
<tr>
<td>2</td>
<td>What do you understand by Petroleum traps? Mention different types of traps with the help of neat sketch</td>
<td>[10]</td>
</tr>
<tr>
<td>2</td>
<td>Write short notes on any three of the following methods of Oil and Gas exploration:</td>
<td>[15]</td>
</tr>
<tr>
<td></td>
<td>(a) Gravity method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Magnetic method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Seismic method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Electric method</td>
<td></td>
</tr>
<tr>
<td>3(a)</td>
<td>Why does well requires Casing and Cementing?</td>
<td>[05]</td>
</tr>
<tr>
<td>3(b)</td>
<td>Define Kick and Blowout. Describe Blowouts prevention and control methods</td>
<td>[10]</td>
</tr>
<tr>
<td>3(b')</td>
<td>Name different types of Drilling Fluids. Explain various functions performed by them.</td>
<td>[10]</td>
</tr>
<tr>
<td>4(a)</td>
<td>Differentiate between Primary, Secondary and Tertiary oil recovery.</td>
<td>[05]</td>
</tr>
<tr>
<td>4(a')</td>
<td>Differentiate between Proven, Probable and Possible oil and Gas reserves.</td>
<td>[05]</td>
</tr>
<tr>
<td>4(b)</td>
<td>Discuss Chemical injection and Thermal method of Enhanced oil recovery in detail</td>
<td>[10]</td>
</tr>
</tbody>
</table>
2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
SEPARATION PROCESSES IN H.C. INDUSTRIES
PK-241

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

1(a) Explain any two of the following:
   - Azeotropic distillation
   - Extractive distillation
   - Reactive distillation

OR

(a') Discuss Murphree tray efficiency & point efficiency with neat sketch. Also explain on which condition these two efficiencies become equal.

(b) A liquid mixture of benzene-toluene is to be distilled in fractionating column at 1.0 atmospheric pressure. The feed (100 kmol/hr) contains 45 mol% benzene and enters at 327 K. The boiling point of feed is 366 K. A distillate containing 95 mol% benzene and bottom containing 10 mol% benzene is recovered. The reflux ratio is 4:1. The average heat capacity of feed is 159 KJ/kmol K and average latent heat of vaporization 32099 KJ/kg mol. Calculate the number of theoretical trays required.

2(a) Prove that ion exchange process is an example of adsorption process with the help of adsorption equilibrium equation.

(b) 100 k mol/h equimolar mixture of A, B, C, & D are fed in to the multicomponent distillation column so that 94 mol% of B is recovered from the top and 96 mol% of C.

Contd......2
from bottoms. The top temperature (dew point) is 70°C & bottoms temperature (bubble point) is 135°C.

Calculate the following:

1. Molar flow rate in top and bottom streams
2. Number of stages for the total reflux
3. Distributions of non-key component in the top and bottom streams.

The relation between K values and temperature are given below.

\[ K_{A} = 0.0002 T^2 + 0.0066 T + 0.3180 \]
\[ K_{B} = 0.0001 T^2 - 0.0014 T + 0.1250 \]
\[ K_{C} = 0.0001 T^2 - 0.0102 T + 0.3167 \]
\[ K_{D} = 0.00009 T^2 - 0.0098 T + 0.3381 \]

Where \( T \) is in °C

(b') An ion exchange column containing 102.3 g of Amberlite ion exchange resin is used to remove \( \text{Cu}^{2+} \) from a solution where \( C_{0} = 0.18 \text{M} \text{CuSO}_{4} \). The tower height = 36.5 cm and the diameter = 2.8 cm., the flow rate is 1.40 cm³ solution/s to the tower. The break through data is shown below.

<table>
<thead>
<tr>
<th>t (s)</th>
<th>420</th>
<th>480</th>
<th>610</th>
<th>540</th>
<th>600</th>
<th>660</th>
</tr>
</thead>
<tbody>
<tr>
<td>C (g mol Cu/l)</td>
<td>0.1433</td>
<td>0.1634</td>
<td>0.1722</td>
<td>0.1763</td>
<td>0.180</td>
<td></td>
</tr>
</tbody>
</table>

The concentration desired at break point is \( C/C_{0} = 0.010 \). Determine the break point time, fraction of total capacity used up to the break point, length of unused bed, & the saturation capacity of the solid.

3(a) Discuss the leaching process with its significance in the chemical/petrochemical industries.

OR

(a') Discuss the "plate and agitated tower" contactor used in the liquid-liquid extraction process with the help of neat diagram.
(b) If 100 kg solution of A and B containing 30 wt % A is to be extracted (cross current) three times with C at 20 ℃, using 40 kg of fresh solvent in each stage. Determine the quantities and composition of various streams. How much solvent would be required if the same raffinate concentration were to be obtained with one stage?

4(a) Explain the classification of membrane process.

OR

What do you understand by membrane process? Discuss its application in oil and gas industry.

(b) Derive the equation for series resistance in liquid membrane process.

(e) Discuss any one the following with the help of neat sketch:

1. Spiral wound membrane
2. Hollow fiber membrane
A desired product L is produced via the following reaction path:

\[
\begin{align*}
A & \rightarrow B + C \\
B + D & \rightarrow E \\
E + 2F & \rightarrow 2G + H + 2D \\
G + D & \rightarrow I \\
I + C + J & \rightarrow F + K \\
2K & \rightarrow L + C + D
\end{align*}
\]

Molecular weight and cost of the species are as given below:

<table>
<thead>
<tr>
<th>Species</th>
<th>Molecular Weight</th>
<th>Cost (Rs/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>47</td>
<td>11</td>
</tr>
<tr>
<td>D</td>
<td>51</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>110</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td>G</td>
<td>86</td>
<td>13</td>
</tr>
<tr>
<td>H</td>
<td>144</td>
<td>17</td>
</tr>
<tr>
<td>I</td>
<td>90</td>
<td>32</td>
</tr>
<tr>
<td>J</td>
<td>58</td>
<td>20</td>
</tr>
<tr>
<td>K</td>
<td>72</td>
<td>36</td>
</tr>
<tr>
<td>L</td>
<td>106</td>
<td>40</td>
</tr>
</tbody>
</table>

Assuming that any species other than I, appearing as a product has no commercial value, determine whether the process has potential for commercialization.
1(b) Mention the heuristics/thumb rules employed to economize the separation tasks. [05]

OR

1'(a) A stream containing propane (45.4 kmol/hr), isobutane (136.1 kmol/hr), n-butane (226.8 kmol/hr), i-Pentane (181.4 kmol/hr), and n-Pentane (317.5 kmol/hr) is to be separated into pure components. Suggest an appropriate separation sequence of ordinary distillation units if the approximate relative volatilities for all adjacent pairs are as follows:

<table>
<thead>
<tr>
<th>Component pair</th>
<th>Approximate α at 1 atm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₂ / iC₄</td>
<td>3.6</td>
</tr>
<tr>
<td>iC₄ / nC₄</td>
<td>1.5</td>
</tr>
<tr>
<td>nC₄ / iC₅</td>
<td>2.8</td>
</tr>
<tr>
<td>iC₅ / nC₅</td>
<td>1.35</td>
</tr>
</tbody>
</table>

1'(b) Acetone is manufactured from isopropanol by the following reaction:

\[ C₃H₇OH + \text{catalyst} \rightarrow C₃H₆O + H₂ \]

The isopropanol is to be preheated to 315 °C and injected into a catalyst-filled reactor where the reaction goes to completion. Suggest a suitable equipment flow sheet. Can we use reactor effluents to preheat the cold isopropanol feed? Give reasons. [05]

1'(c) What are the roles and significance of “Species Allocation” and “Task Integration” in Process Synthesis? [05]

2(a) Discuss, in brief, the significance and salient features of Block Flow Diagram (BFD), Process Flow Diagram (PFD) and Piping & Instrumentation Diagram (P&ID). [07]

2(b) Following symbols are used to represent specific information on a Process Flow Diagram.

Mention the information for which each of these symbols are used. [03]

Contd....3
2(c) Prepare the simplest principal type of flowsheet for the following process and indicate the flowrates of the principal chemical components:

A refinery stream containing paraffins and a mixture of aromatics (benzene, toluene, xylene, and heavier aromatics) is extracted with a liquid solvent to recover the aromatics. The solvent and aromatics are separated by distillation, with the solvent recycled to the extraction column. The aromatics are separated in three columns, recovering benzene, toluene, and mixed xylenes, in that order. The feed stream consists of the following:

- Paraffins 300,000 kg/h
- Benzene 100,000 kg/h
- Toluene 180,000 kg/h
- Xylene 20,000 kg/h
- Heavy aromatics 40,000 kg/h

A 3-to-1 weight ratio of solvent to aromatics is used.

3 A Process Flow Diagram (PFD) for the production of Benzene via the hydrodealkylation of toluene is shown in Fig Q3. Identify the primary chemicals and establish the primary reaction pathway. Show the primary pathway on the flowsheet and describe the same. Also, show the material balance of primary chemicals using the information given in Table Q3.

4(a) Describe in detail, the storage of non-volatile liquids, volatile liquids and gases. Also discuss large capacity storage tanks that are beyond the scope of design codes.

4(b) Mention various types of supports that are employed for vertical and horizontal vessels. Explain the supports that are most frequently employed.

4(c) Mention the standard number and title of any two design codes and briefly discuss their scopes.

OR

4' A process vessel having the nominal diameter of 1.5 m and tangent to tangent length of 3.0 m is to be operated at the maximum internal pressure of $Z$ kN/m², where

- $Z = Y$, if $Y \geq 100$
- $Z = 10Y$, if $10 \leq Y < 100$
- $Z = 100Y$, if $Y < 10$

$Y$ = last three digits of your Faculty number.
The permissible stress value of the material of construction is 120 MN/m². Assuming the corrosion allowance of 3 mm:

(a) Determine the thickness of the shell plate to be used for fabrication

(b) Determine the maximum pressure a spherical vessel of same diameter, material of construction and thickness will withstand safely.
<table>
<thead>
<tr>
<th>Stream Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>25</td>
<td>59</td>
<td>25</td>
<td>225</td>
<td>41</td>
<td>509</td>
<td>41</td>
<td>38</td>
<td>684</td>
<td>91</td>
<td>147</td>
<td>112</td>
<td>112</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>Vapor Fraction</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
Alternate Fuels & Energy Resources
PK 243A

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)  Calculate the energy in 1 tonne of oil equivalent in —
   i. kcal
   ii. Quad
   [04]
1(b)  What is Hubbert Peak theory in concern with energy security?
   [03]
1(c)  Differentiate between CNG and LPG.
   [02]
1(d)  What is biodiesel? What are its advantages and limitations compared to petroleum diesel?
   [06]

OR

1(d') What is Trans-esterification Reaction? List down the various factors affecting the reaction.

2(a) What do you mean by GTL technologies? What are the drivers for chemical conversion of Natural Gas using GTL technologies?
   [05]
2(b) What do you mean by Tar Sand? How is it different from Oil Shale? List down the various methods of extraction of Tar Sand.
   [05]
2(c) Describe the working principle of SAGD technique for Tar sand recovery. What are its advantages and limitations?
   [05]

OR

2(c') Draw the block diagram of overall GTL process.

Contd......2
3(a) What do you mean by Coal to Liquid technologies? How is it beneficial?

3(b) What do you mean by FSI of coal? Write down its significance.

3(c) Write short note on In-Situ gasification describing its working with a neat sketch.

OR

3(c') Describe the working principle of a Koppers-Totzek gasifier with a neat sketch. Also mention its significant features.

4(a) What is the principle of solar photovoltaic? Explain its working with a neat sketch.

4(b) Calculate the declination angle for March 31 in a leap year.

4(c) The undisturbed wind speed at a location is \( v_i = 30 \) mile/hour, the speed at turbine rotor is \( 60\% \) of this value, and the speed at exit is \( 80\% \) of \( v_i \). The rotor diameter is \( 9 \) m, density of air is \( 1.293 \) kg/m\(^3\). Calculate-

i. \( v_i \) in m/s
ii. Power available in undisturbed wind at turbine rotor
iii. Power available in air at exit
iv. value of coefficient of performance of the turbine and comment on the result

OR

4(c') Spectral density of a wave is given in the figure. 1. Calculate the followings-

i. Significant wave height
ii. Power potential per meter length of the wave

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Figure 1: Spectral density of the wave