2014-15
B.TECH. AUTUMN (VII SEMESTER) EXAMINATION
(Chemical Engineering)
Energy Engineering And Management
(CH-410)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No. Question Give M.M.
1(a) List out the various future energy resources in India, with brief description. [03]
1(b) Discuss at least two renewable and non-renewable sources of energy. And also its impact on the environment. [04]
1(c) Explain in detail the experimental method for the determination of calorific value of a solid fuel. [05]

OR

1(c') Discuss the Proximate Analysis of a coal and its importance. [05]

2(a) Mention the characteristic of solid fuel? [02]
2(b) Explain the various steps involved in coal preparation. [03]
2(c) Define any two of the following terms:
   i. Coal carbonization
   ii. Water gas composition and its characteristics
   iii. Gasoline composition and its characteristics
   OR

2'(a) Describe various type of burners used in chemical and allied industries. [05]
2'(b) Calculate the gross and net calorific value of a coal which analyses C=74%, H=6%, N=1%, O=9%, S=0.8%, Moisture=2.2%, Ash=8%. [04]
2'(c) Explain the classification of fuel and discuss its advantages and disadvantages. [03]

3(a) Explain the production of Biogas with neat diagram. And also explain the effect of temperature and PH at the rate of bio gas formation. [06]

OR

3(a') Describe the production of ethanol from cellulosic biomass with the help of a process flow diagram? [06]
3(b) Describe various types of gasifier with its advantages and disadvantages. [03]

Contd...2.
3(c) Define any two of the following term:
   i. Pyrolysis of biomass
   ii. Gasification of biomass
   iii. Syngas composition and its uses.

4(a) Define any two of the following term:
   i. Solar Azimuth angle
   ii. Solar constant
   iii. Declination angle
   iv. Hour angle

4(b) List out the devices for thermal collection and storage and explain one of them.

4(e) Calculate the angle made by beam radiation with the normal to a flat plate collector on May 1 at 0900 hr (Local apparent time). The collector is located in New Delhi (28°35'N, 77°12'W). It is tilted at an angle of 35° with the horizontal and is pointing due south.

OR

4(c) Describe the performance analysis of liquid flat plate collector.

4(d) Describe the working of Solar Pond.

5(a) List the devices for the efficient recovery of energy from solid, liquid and gases fuel. Explain one of them.

5(b) Discuss in detail the scheme of energy saving in Nitrogenous fertilizers industry or steel industry?

5(c) What do you understand by Energy Audit? Explain it clearly.
1. In a non isothermal tubular reactor, where a simple first order reaction A → B takes place, the mass and heat balance are given by:

\[ \frac{\delta x}{\delta t} + v \frac{\delta x}{\delta z} = -kx \]

\[ c_p \rho A \frac{\delta T}{\delta t} + c_p \rho v A \frac{\delta T}{\delta z} = hA_1(T_e - T) + (-\Delta H_v)kA_x \]

Where \( x \) and \( T \) are composition and temperature of the reacting mixture within the reactor; \( \rho, c_p, (-\Delta H_v)A_1, \nu, hA_1 \) and \( T_e \) are constant values and \( k \) is the kinetic rate parameter expressed by:

\[ k = k_0 e^{\left(\frac{-E}{RT}\right)} \]

Where \( k_0, E \) and \( R \) being constant.

Linearize the above expression.

OR

1(a) Write briefly about input output, state, manipulated and load variables.

1(b) Explain, in brief, with suitable example and appropriate diagram the feed forward and feedback control strategy.

1(c) Compare the solution of the first order differential equation by Laplace transform with that of the traditional method (using integrating factor). Take suitable example.

2. Develop the expression for the value shown by thermometer if it is suddenly exposed to an environment which is 30 °C lower than its initial value. Tabulate the temperature indicated versus time if the thermometer shows a reading of 29 °C after 2.2 minutes. The initial reading of the thermometer is 48 °C. Give an approximate idea of time when steady state shall be reached.

OR

Contd.... 2.
2. A first order process with gain and time constant of 1 and 0.2 minutes respectively subjected to sinusoidal input with amplitude of 0.03 m³/min about a mean flow rate of 0.3 m³/min. The frequency of input sine wave is 4 cycles/min. Derive the expression to determine the response. Tabulate the temperature versus time.

3. Using the Bode stability criterion, find the range of $K_c$ values that stabilize the process:

$$G_p(s) = \frac{e^{-0.2s}}{3s + 1}$$

The controller is proportional and $G_m, G_c$ has unit value.

4(a) Write the discretized form of the following differential equation.

$$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + x = Km$$

4(b) Write in brief about different components of the digital computer control loop.

4(c) Calculate the final value of $y(t)$ if

$$y(z) = \frac{1 + 2z^{-1} + 0.1z^{-2}}{(1-z^{-1})(1-0.2z^{-1})(1+2z^{-1}+z^{-2})}$$
1(a) Explain the 'Onion Model' of process design for a Petroleum refinery.

1(b) For the manufacture of vinyl chloride, following three reaction paths are available.

\[ \text{C}_2\text{H}_2 + \text{HCl} \rightarrow \text{C}_2\text{H}_3\text{Cl} \]  
Acetylene vinyl chloride  

\[ \text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} \]  
Ethylene dichloroethane  

\[ \text{C}_2\text{H}_2\text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl} \]  
Dichloroethane vinyl chloride  

\[ \text{C}_2\text{H}_4 + \frac{1}{2} \text{O}_2 + \text{HCl} \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 + \text{H}_2\text{O} \]  
Dichloroethane  

\[ \text{C}_2\text{H}_4\text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl} \]  
Dichloroethane vinyl chloride

The market values of the materials involved are:

\begin{center}
<table>
<thead>
<tr>
<th>Species</th>
<th>Rs /kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene</td>
<td>120</td>
</tr>
<tr>
<td>Chlorine</td>
<td>55</td>
</tr>
<tr>
<td>Ethylene</td>
<td>85</td>
</tr>
<tr>
<td>Hydrogen Chloride</td>
<td>49</td>
</tr>
<tr>
<td>Vinyl Chloride</td>
<td>54</td>
</tr>
</tbody>
</table>
\end{center}

Oxygen is taken to be free coming from air, which reaction path makes most sense on the basis of raw material, product and byproduct values?
1′(a) What are the decisions that must be made regarding method of temperature control in the reactor?

1′(b) Benzene is to be produced from toluene according to the reaction:

\[ \text{C}_6\text{H}_5\text{CH}_3 + \text{H}_2 \rightarrow \text{C}_6\text{H}_6 + \text{CH}_4 \]

Toluene benzene

Some of the benzene formed undergoes a number of secondary reactions in series to unwanted byproducts that can be characterized by the reaction to diphenyl according to the reaction:

\[ 2\text{C}_6\text{H}_6 \rightarrow \text{C}_{12}\text{H}_{10} + \text{H}_2 \]

Benzene diphenyl

The compositions of the reactor feed and effluent streams are:

<table>
<thead>
<tr>
<th>Component</th>
<th>Inlet Flowrate (kmol/h)</th>
<th>Outlet Flowrate (kmol/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{H}_2 )</td>
<td>1858</td>
<td>1583</td>
</tr>
<tr>
<td>( \text{CH}_4 )</td>
<td>804</td>
<td>1083</td>
</tr>
<tr>
<td>( \text{C}_6\text{H}_6 )</td>
<td>13</td>
<td>282</td>
</tr>
<tr>
<td>( \text{C}_6\text{H}_5\text{CH}_3 )</td>
<td>372</td>
<td>93</td>
</tr>
<tr>
<td>( \text{C}<em>{12}\text{H}</em>{10} )</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Calculate the conversion, selectivity and reactor yield with respect to

(i) Toluene feed
(ii) Hydrogen feed

2′(a) With the help of diagrams discuss the factors that dictate the recycle structure of a process.

2′(b) A mixture of four species in amounts \( D_1, D_2, D_3, \) and \( D_4 \) kg/hr is to be separated into pure components and the property difference to be exploited has gaps of \( \Delta_{12}, \Delta_{23}, \Delta_{34} \) between adjacent species.

(i) Determine the minimum separation load if \( D_1 : D_2 : D_3 : D_4 = 1 : 2 : 3 : 4 \)

(ii) Calculate the difficulty of separation for minimum separation load sequence given that \( \Delta_{12} = 2 \Delta_{23} = \Delta_{34} = \Delta \)
3. Analyze a $N$ stage distillation column with one feed, a total condenser and a partial reboiler and propose a feasible set of design variables.

OR

3'(a) Discuss in brief about the reversal of information flow that result due to reselection of design variable and its effect on ease of computation.

3'(b) Find out the degrees of freedom and draw flow diagram for the counter current flow heat exchanger.

4(a) State and prove the deduction theorem of propositional logic.

4(b) Which factors should be considered for selection of site for a chemical plant, discuss in detail any four of them.

4(c) Discuss various pollution abatement measures in a chemical plant.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
PETROLEUM PROCESSING
CH-442 (DE)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
</tr>
</thead>
</table>
| 1     | Answer *any five* of the following questions briefly.  
(i) Describe briefly the chemical composition of petroleum?  
(ii) Mention what you understand by the oxidation stability of gasoline? Name the tests for assessing it.  
(iii) Explain the procedure for the ASTM distillation for light distillates.  
(iv) Describe briefly the US Bureau of Mines method for the classification of crude oils.  
(v) Write a note on the harmful effects of the petroleum refining industry on the environment.  
(vi) Explain the mechanism of 'knock' in a spark ignition engine. How is it measured? |
|       | [03x5=15]                   |

2(a) What is meant by 'overlash' in an atmospheric distillation unit (ADU)? What is its significance? What is the role of steam in an ADU? Explain with the help of a neat flow sheet, the working of an ADU in a modern refinery.

2(b) What is meant by 'sweetening' in a refinery? Discuss a sweetening process that is widely used in refineries with the help of neat process diagram.

OR

(a') Why is vacuum employed in the distillation of crude oil? List the different objectives for which vacuum distillation units (VDUs) are designed. Explain with the help of a neat flow sheet, the working of a VDU.

2(b) What is meant by 'sweetening' in a refinery? Discuss a sweetening process that is widely used in refineries with the help of neat process diagram.

OR

Contd... 2.
3(b) Answer any one of the following questions.

(i) Discuss the reaction mechanism of thermal cracking.
(ii) Catalyst regeneration in the FCC.

4(a) What is meant by light ends management in a refinery? Explain a process that helps in managing efficiently the light ends in a refinery.

(b) Explain the reaction mechanism of catalytic alkylation.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
PETROLEUM PROCESSING
CH-452N (DE)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No. | Question | M.M.
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1 | Answer any five of the following questions briefly. (i) Describe briefly the elemental composition of petroleum? (ii) List the various sources of gasoline in a refinery. (iii) Explain the procedure for determining the Viscosity Index of a lube oil. (iv) Describe briefly, the different types of refineries. (v) For any three process units in a refinery, give the feed stocks used and the products obtained. (vi) Explain the mechanism of 'vapor-lock' in a spark ignition engine. How is it measured and controlled? | [03x5=15]

2(a) | How is vacuum created in a vacuum distillation unit (VDU)? Explain with the help of a neat flow sheet, the working of a vacuum distillation unit (ADU) in a modern refinery. | [09]

OR

(a') Describe the hydro-treating process in a refinery with special reference to the flow sheet, the chemical reactions and the process variables.

2(b) | Explain with a neat sketch, the working of a lube-still heater for heating crude oil. | [06]

OR

(b') What are the different impurities found in crude oil? Explain the electric desalting process for the desalting of crude as employed in modern refineries.

3(a) | Describe with a neat flow sheet the Delayed Coking process or the catalytic reforming process. | [10]

3(b) | Answer any one of the following questions. (i) Discuss the reaction mechanism of catalytic cracking. (ii) Gas oil maximization in visbreaking. | [05]

4(a) | Explain a process that efficiently utilizes the light ends in a refinery to produce a high octane gasoline blend. | [10]

(b) | Mention the undesirable characteristics of lube oil base stocks. How are they controlled? | [05]