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) Develop a dynamic model for an ideal binary distillation column. State necessary assumptions. 

(b) Develop a dynamic model for steam heated exchanger. State required assumptions.

OR

1'. Develop a steady state model for a CSTR (first order reaction) followed by N separation units which are connected in series. Also determine how one can find optimum values of dependent variables?

2(a) For a feedback control system with \( G_p = \frac{1}{12s^2 + 2s + 1} \), \( G_f = G_m = 1 \), find the characteristic equation and hence check the stability for the system, using routh array method.

2(b) Discuss time integral performance criteria for controller design. Also discuss the selection method to choose the most suitable for a particular application.

2(c) Define phase and gain margin for a system.

2(d) Explain any one from the following:

(i) Sampling time

(ii) Hold element

3(a) Why ratio control is considered as feedforward control, explain with the help of an example. Also discuss about the applications of ratio control in industries.

cont'd... 2
3(b) Explain auctioneering control system for catalytic tubular reactor with the help of precise diagram.

3(c) Find the inverse z-transform using long division method:

\[ \hat{y}(z) = \frac{1 - 0.1z^{-1} + 3z^{-2}}{2 + 3z^{-1} + z^{-2} - 0.1z^{-3} + z^{-4}} \]

4. Develop a linear model for plate gas absorber unit, having the dynamic model as:

\[ H \frac{dx_n}{dt} = L . x_{n+1} - (L + mV) . x_n + mV . x_{n-1} \]

where, \( H \) = liquid holdup,
\( m \) = constant,
\( x_n \) = liquid composition,
\( L \) and \( V \) = liquid and vapour flow rates respectively,
\( n \) = No. of plates.

OR

4'(a) For the given control loop determine corresponding inferential control system:

\[ \begin{align*}
G_{d1} & \quad G_{d2} \\
G_{p1} & \quad \times \quad G_{p2} \\
& \quad \times \\
& \quad y
\end{align*} \]

Where,

\[ G_{p1} = \frac{2 e^{-2s}}{15 s + 1}, \quad G_{p2} = \frac{3}{12 s + 1}, \quad G_{d1} = \frac{0.5 e^{-s}}{35 s + 1}, \quad G_{d2} = \frac{e^{-s}}{25 s + 1} \]

(b) Discuss why and how continuous signals are converted to discrete signal?

(c) Determine discrete time model for a second order process.
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 the basic feedstocks for fortune of petrochemicals? Explain briefly.  [05]
1(b)  Discuss about basic characteristics of ethylene which makes it “king of petrochemicals”?  [04]
1(c)  Describe the steam cracking process of olefin production from ethane with the help of a neat process flow sheet. Also explain the functions served by steam in the process.  [06]

OR

1'(c)  Discuss the procedure of making hydrogen cyanide in the presence as well as in absence of air.

2(a)  Discuss and describe the UOP Montedison process with the help of process flow sheet. Also discuss the reason for keeping operating temperature above the oxidation temperatures.  [10]
2(b)  What do you understand by hydroformylation? Discuss catalytic hydroformylation reactions, with reaction kinetics.  [05]

3  Describe the significance of catalytic alkylation process. Explain UOP alkylation process, with the help of process flow sheet, and compare it with Time tank process.

OR

3'(a)  Discuss and describe Badger process to produce ethyl benzene with the help of neat process flow sheet.  [07]

contd... 2
3' (b) Discuss the applications of disproportionation and hydrodealkylation reactions in industries. Also explain why disproportionation is preferred over hydrodealkylation of alkyl aromatics?

4 Discuss and describe UOP butamer catalytic isomerization process with the help of neat process flow diagram. Also discuss the effect of various process variables.

OR

4' (a) Discuss environmental, political and economical aspects of gas to liquid technology.
(b) What do you understand by ester hydrolysis? Discuss alkaline and acidic hydrolysis with the help of reaction mechanism.
(c) Give the reactions involved in any five of following:
   i. Chlorohydrin process, to produce propylene oxide from propylene
   ii. Hydrolysis of ethylene
   iii. Carboxylation of toluene
   iv. Dehydration of adipic acid to form adiponitrile
   v. Preparation of oxamide
   vi. Nitration of toluene
1(a) Differentiate between; 
(i). Polymer and Polymer-Composites 
(ii). Thermoplastic and Thermosets . 
(iii). The role of fiber and matrix. 

1(b) Compare the bulk and suspension polymerization techniques on the basis of purity, ease of process control and molecular weight distribution. 

OR

In a polymer fractionation experiment the following data was obtained:

<table>
<thead>
<tr>
<th>Mol. Wt. of fraction</th>
<th>100</th>
<th>200</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Chain</td>
<td>5</td>
<td>12</td>
<td>18</td>
<td>22</td>
<td>15</td>
<td>11</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

Calculate the number average and weight average molecular weight of polymer. Also calculate the polydispersity index.

2(a) What do you mean by stereo regularity of polymers? How it influences the properties of polymer, discuss it.
2(b) What do you mean by crystallinity of a polymer? How can we regulate the crystallinity during processing of polymer with its effect on the mechanical properties of polymer?

OR

2(b') What do you mean by transition temperatures in polymers? Other than glass transition temperature explain any other transition temperature. Briefly explain the factors affecting glass transition temperature.

3 A hybrid composite material is made up of 25% Carbon fiber by weight and 20% S-glass fiber by weight in an polyester matrix. If the densities of polyester, carbon fiber, S-glass fiber are 1100 kg/m$^3$, 1750 kg/m$^3$, and 2410 kg/m$^3$ respectively. Calculate the density of composite.

OR

3' Differentiate between the followings with the help of examples and/or equations:

(i). Orthotropic and isotropic materials.
(ii). Specially Orthotropic lamina and generally orthotropic lamina.
(iii). Critical fibre volume and critical fibre length.
(iv). Compliance matrix and Reduced transformed compliance matrix.
(v). Shear - shear coupling coefficients and constants of mutual influence.

4(a) What do you mean by biaxial strength of orthotropic lamina? compare the maximum stress theory with maximum strain theory.

4(b) Explain the manufacturing process for sheet molding compound (SMC). Write 3 industrial applications for SMC and name the most common molding technique where SMC is used as raw material.
2013-14
M.TECH. (WINTER SEMESTER) EXAMINATION
(PETROCHEMICAL ENGINEERING)
GAS PROCESSING
PK-608
Credits: 04

Maximum Marks: 60
Duration: Three Hours.

Answer the following questions

Q No 1

2.0×5 = 10.0

a) Mention the typical composition of natural gas.

b) What is the recommended value of water and H₂S content in the natural gas?

c) Define dew point and dew point depression with reference to natural gas.

d) Why heavy hydrocarbons particularly unsaturated and aromatic hydrocarbons are very detrimental to the performance of most sulfur recovery processes by physical adsorption.

e) List the categories of sweetening processes on the basis of regeneration along with one example.

Q No 2

3.0×5 = 15.0

(a) Define and compare the differential & flash separation processes for oil/gas separator.

OR

(a') Mention the selection of stages on the basis of GOR & API

(b) Find the 2nd stage pressure using equal pressure ratio for a three stage separation if p₁ = 800 psia.

(c) List the parameters and their effects on the water content of natural gas.

OR

(c') Write down the structural formula for gas hydrates types of I,II & H.

(d) Discuss in brief the three common methods for prevention of hydrate formation.

(e) Why water wash process is preferred before amine solvent process in desulfurization of natural gas.
Q No 3

(a) Discuss the problems associated with foams in the oil/gas separator

(b) Estimate the water content of natural gas at 100 °F and 1000 psia using 1) Robinson et al method & 2) Campbell's method. The gas composition is as follows: \( \text{CH}_4 = 80.0\% \), \( \text{C}_2\text{H}_6 = 5.0\% \), \( \text{C}_3\text{H}_8 = 1.5\% \), \( \text{nC}_4\text{H}_{10} = 0.5\% \), \( \text{CO}_2 = 2.5\% \), \( \text{H}_2\text{S} = 8.5\% \).

**OR**

(b') How far can the pressure be lowered without expecting the hydrate formation for a 0.65 gravity gas if it is initially at
- 1500 psia and 100 °F
- 1000 psia and 100 °F

(c) Discuss the advantages of using molecular sieve as a solid bed in adsorption process for treating natural gas.

(d) Describe the water wash process with the help of process flow diagram.

(e) List the commonly used chemical solvent with chemical formula in the alkanol amine processes. Also mention the most widely used solvents with reference to their advantages.

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Q No 4

Discuss the merits & demerits of Horizontal and Vertical separators. A separator to be operated at 1000 psia is required to handle a well stream with gas flow rate 7.0 MMscfd at a GLR = 40 bbl/MMscf. Determine the separator size for
1. Vertical separator
2. Horizontal single tube separator
Assume a liquid density of 52 lbm/ft\(^3\), ideal gas with gravity=0.8, operating temperature = 110 °F, retention time = 3.0 minutes, liquid level in separator = half(\(^1/2\)) full condition. Value of \( K = 1.67 \) for vertical separator and 0.382 for horizontal separator.

**OR**

Design an adsorber for dehydrating 20.0 MMscfd of a 0.7 gravity gas at 1000 psia and 100 °F. Assuming a two tower plant using an 8 hr cycle with a 15 ft long silica bed. The water content of inlet natural gas = 60 lb H\(_2\)O/MMscf gas. Gas compressibility factor, \( Z = 0.88 \). Initial assumption for gas velocity = 1800 ft/hr. Gas saturation with water is 100 %
Permissible Expansion of a 0.7-Gravity Natural Gas Without Hydrate Formation

See Caution on Fig. 20-19. Fig (2)
Figure 1: Effective water content of saturated H₂S in natural gas mixtures (Campbell, 1976).

Figure 2: Effective water content of saturated CO₂ in natural gas mixtures (Campbell, 1978).

Water Content (% by Volume) vs. Pressure (psi) for different temperatures.