Code No: **RT41082** **R13** **Set No. 1**

IV B.Tech I Semester Regular/Supplementary Examinations, October/November - 2017

CHEMICAL ENGINEERING PLANT DESIGN

(Chemical Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A *(22 Marks)*

1. a) Enunciate the criteria for optimum design of a chemical process plant. [4]
   b) Draw the symbols used in PFD and PID for the following: Heater, Jacketed & Agitated vertical reactor, All control valves, pressure controller. [4]
   c) What is the criteria for selection of vacuum equipment? [4]
   d) What is dirt factor and its significance in thermal design of shell and tube heat exchangers? [3]
   e) Write down the steps involved in the design of a packed column. [4]
   f) Sketch a schematic for recycle reactors. [3]

PART–B *(3x16 = 48 Marks)*

2. a) What are the process design steps for implementing a chemical process commercially? [8]
   b) Present a check list for a typical chemical process plant layout. [8]

3. a) Classify and discuss various types of process designs. [8]
   b) Distinguish between process flow diagrams and piping and instrumentation diagrams with examples. [8]

4. a) Write down the design criteria of centrifugal pumps. [8]
   b) Calculate insulation thickness (minimum value) required for a pipe carrying steam at 180^0C. The pipe size is 8" and the maximum allowable temperature of outer wall insulation is 50^0C. Thermal conductivity of the insulation material for the temperature range of the pipe can be taken as 0.04 W/m.K. The heat loss form steam per meter of pipe length has to be limited to 80 W/m. [8]

5. a) With the help of a flow chart, describe the design of a shell and tube heat exchanger by Kern method. [8]
   b) 45,000 kg/hr of mixed light hydrocarbon vapors are condensed at 10 bar. The saturated vapor will enter the condenser at 60^0C and the condensation will be complete at 45^0C. Enthalpy of vapor is 596.5 kJ/kg and the condensate 247.9 kJ/kg. Cooling water is available at 30^0C and the temperature rise is to be limited to 10^0C. Calculate the cooling water flow (Specific heat of water= 4.18 kJ/kg ^{0}C) [8]

6. a) Discuss the criteria for selection of liquid-liquid extractors. [8]

b) A saturated liquid mixture of acetone and water contains 55 mole % acetone and 45 mole% water is to be separated by distillation at 1 atm. The desired top and bottom product compositions are 96 mole% acetone and 2.5 mole% acetone respectively. The operating reflux ratio is to be employed is 1.5. The column will have a total condenser and partial reboiler.
Determine total theoretical plates required to effect this separation using McCabe-Thiele method and locate the feed plate.
Equilibrium data for acetone – water mixtures at 1 atm are given below:
(x = mole fraction of acetone in liquid and y = mole fraction of acetone in vapor)

x	0.0	0.05	0.10	0.20	0.30	0.40	0.50
y	0.0	0.638	0.730	0.791	0.812	0.827	0.839
x	0.60	0.70	0.80	0.90	0.95	1.0	
y	0.853	0.871	0.895	0.933	0.963	1.0	

[8]

7. a) Classify the reactors with neat sketches giving industrial examples. [8]
b) Butyl acetate formation is carried out in a batch reactor at 90^0C with sulfuric acid as a homogeneous catalyst. The feed contained 4.97 moles of n-butanol per mole of acetic acid and catalyst concentration is 0.032% by mass as H_2SO_4. Rate equation for this reaction is – $r_A = kC_A^2$ where C_A = concentration of acetic acid in mole/cm^2 and k = 17.4 cm^3/ (mol-min). Density of reaction mixture at 90^0C can be assumed constant and equal to 0.75 g/cm^3. Calculate the time required to obtain 50% conversion. [8]