BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2017

(4th Year, 2nd Semester)

CHEMICAL PROCESS SYNTHESIS

Time: Three hours | Full Marks: 100

Assume any missing data

All the symbols have their usual meaning

Answer ALL the questions

1. Consider the following process streams available in a plant and using Pinch Technology for Heat Exchanger Network, find the following:

Stream No.	Inlet temperature (°C)	Outlet temperature (°C)	Heat capacity (kW/°C)
1	450	350	1.0
2	450	350	1.2
3	320	400	1.0
4	350	420	2.0

a) Draw a composite hot and cold streams diagram on a graph paper. **[12]**

b) Indicate the pinch location with an approach temperature of 20°C on the plot. **[2]**

c) The hot and cold utility load from the plot with the same approach temperature. **[3]**

d) Design a proper Heat Exchanger Network indicating all the heat loads and intermediate temperatures with same approach temperature. **[8]**

2. There are eight pipe lines which are carrying process fluids in a chemical plant. The stream description is given in the following table.

Stream No.	Inlet temperature (°C)	Outlet temperature (°C)	Heat capacity (MW/°C)
1	150	100	0.043
2	100	40	0.005
3	175	150	0.36
4	150	40	0.02
5	250	60	0.025
6	15	180	0.05
7	215	220	0.68
8	230	235	1.60

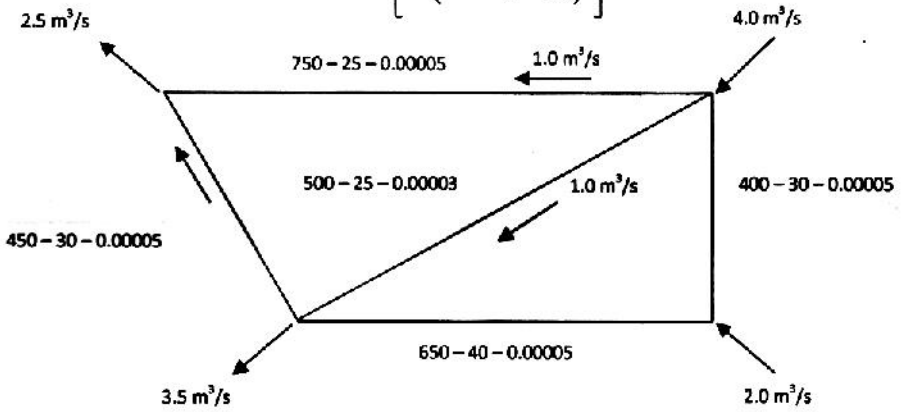
To make a proper network of heat exchanger using 'Pinch Technology', find

a) The hot and cold stream temperatures at the pinch location, and the hot and cold utility load with an approach temperature of 10°C by Temperature Interval Diagram (**TID**) Method. **[10]**

b) Construct the possible Heat Exchanger Network with same the approach temperature. **[15]**

3. The pipe network shown in next page is to be analyzed by the Hardy Cross method. The geometry is labeled on each pipe [i.e. length (L) of the pipe in meter, diameter (D) of the pipe in cm and roughness (e) of the pipe in meter]. The kinematic viscosity of fluid is 1.1×10^{-6} m^2/s. Find the flow rate in each pipe through the proposed analysis method in a tabular form (**complete ONE iteration**). The initial guess of flow rate and direction in some of the pipe are indicated in figure. The head loss is to be determined from **Darcy Weisbatch formula.** The friction coefficient can be determined using **Colebrook approximation by Moody**: **[25]**

$$f = 0.0055\left[1+\left\{2\times10^4\frac{e}{D}+\frac{10^6}{\mathrm{Re}}\right\}^{\frac{1}{3}}\right]$$



4. a) Develop an optimal separation flowsheet using Motard empirical method to achieve goals G_1, G_2 and G_3 when two streams S_1 and S_2 are available. The order of achieving the goal is G_2, G_1 and G_3. Show the necessary table and procedure for Motard empirical method for minimization of separation load. **[15]**

Stream	Components	
	X_A	X_B
S_1	4	5
S_2	8	6
G_1	2	0
G_2	6	7
G_3	4	4

b) Discover the best sequence and rank among those possible for the separation of the mixture given below based on marginal vapor rates in ordinary distillation columns. **[10]**

Species	Relative volatility	Amount in kmol/hr
A	4.5	25
B	1.8	60
C	5.0	20
D	1.2	100