

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY
ME – SEMESTER I (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2711606

Date: 19/05/2016

Subject Name: Energy and mass Integration

Time: 02:30 pm to 05:00 pm

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** To explore the possibilities for energy integration before designing a column, we need to prepare inter-cooling and inter-heating curve. Explain the step by step procedure to plot it for a mixture of four hydrocarbons in the series, C3 to C6, where C6 amount is large (about 65%) in feed. **07**
- (b)** For the Heat Exchanger Network Synthesis (HENS) problem following stream information is available: **07**

Stream	T _{in} °K	T _{out} °K	FC _p kW/°K
C1	360	480	3
C2	330	400	2
H1	480	340	2
H2	450	340	4

- Q.2 (a)** Draw HCC and find out pinch point for $\Delta T_{min} = 10$ °K. **09**
- Mass exchanger network is to be designed for removal of H₂S from sour coke oven gas, which is a mixture of H₂, CH₄, CO, N₂, NH₃, CO₂ and H₂S. It is proposed to remove H₂S and sent it to a unit to convert it to sulfur. The conversion is incomplete in that unit hence tail gases must be sent for H₂S removal. Adsorption is to be used for H₂S removal using aqueous ammonia or chilled methanol as MSA.

Stream	F (kg/s)	y ^s or x ^s	y ^t or x ^t
Coke oven gas	0.9	0.0700	0.0005
Tail gases	0.1	0.0510	0.0003
Aq. NH ₃	2.3	0.0008	0.0310
Methanol	Unlimited	0.0001	0.0035

Equilibrium data is $y = 1.45x$ for aqueous ammonia and $y = 0.26x$ for chilled methanol. Find out pinch point and minimum amounts MSE.

- (b)** Explain Multi Effect Distillation **05**
- OR**
- (b)** Explain preheating or cooling of feed for energy integration in distillation. **05**
- Q.3** Find out pinch point for the following network and write MILP model for minimum number of Heat Exchangers in the network: **14**

	F _{cp} (kW/°K)	T _{in} (°K)	T _{out} (°K)
H1	2.376	590	400
H2	1.577	471	400
H3	1.320	533	350
C1	1.600	350	600
C2	1.600	400	630
C3	4.128	400	600
C4	2.624	350	580

OR

- Q.3** Determine the minimum utility consumption for the hot and cold streams given below using LP transshipment formulation. **14**

	FCp (kW/°K)	T _{in} (°K)	T _{out} (°K)
H1	1.60	400	730
H2	3.27	480	650
H3	2.60	500	700
C1	2.80	740	450
C2	2.38	820	600
C3	3.36	690	450

Heating Utility : 230 °C, Cooling Utility : 23 °C, $\Delta T_{\min} = 15$ °C

Write a model for minimum utility cost if H1 and C2 are not allowed to exchange heat for the above Heat Exchanger Network Synthesis (HENS) problem.

- Q.4 (a)** For the Heat Exchanger Network Synthesis (HENS) problem following stream information is available: **07**

Stream	T _{in} °K	T _{out} °K	FC _p kW/°K
C1	360	480	300
C2	330	405	260
H1	480	340	200
H2	450	340	400

Find out pinch point for $\Delta T_{\min} = 10$ °K.

- (b)** Determine the minimum utility consumption for the hot and cold streams given below using LP transshipment formulation. **07**

	FCp (MW/°K)	T _{in} (°K)	T _{out} (°K)
H1	1.8	450	350
H2	1.5	450	350
C1	1.3	320	400
C2	2.2	320	420

Heating Utility : 500 °K, Cooling Utility : 300 °K, $\Delta T_{\min} = 10$ °K

OR

- Q.4 (a)** Compare the sequential optimization and simultaneous optimization approaches for HENS. **05**
- (b)** List out methods with strengths and limitations which we can use to find out pinch point temperature for the following stream information. Using any method of your choice find pinch point using $\Delta T_{\min} = 15$ °K. **09**

	FCp (MW/K)	T _{in} (°K)	T _{out} (°K)
H1	2.4	590	450
H2	1.5	570	400
C1	1.6	400	550
C2	1.6	330	430

- Q.5 (a)** Explain CI method for Mass Exchanger Network Synthesis. **07**
- (b)** Explain the concept of Heat Pumping and discuss its strengths and weaknesses with a specific case study. **07**

OR

- Q.5 (a)** Compare a distillation column with side stripper, and conventional two column system taking a case study. Draw TQ diagram for both cases. **07**
- (b)** Explain the analogy of Heat Exchanger Network Synthesis and Mass Exchanger Network Synthesis. **07**
