Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code: 711606

Subject Name: Energy and Mass Integration

Date: 27 / 01 / 2010 **Time: 12.00 – 2.30 PM**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Draw sketches wherever necessary & assume appropriate data if required.**
3. **Figures to the right indicate full marks.**
4. **Notations used have conventional meaning.**

Q-1 **(a)** Discuss the effect of minimum temperature driving force, ΔT_m for design of heat exchanger network. Explain the Threshold Approach Temperature (ΔT_{thres}) and give suitable example to clearly differentiate ΔT_{thres} and ΔTm. **06**

(b) Explain method for finding and removing heat loops to minimize number of Exchanger units for the heat exchanger network. **06**

Q-2 **(a)** What is stream splitting? Explain how stream splitting can help in getting better design alternatives. The following streams exist at and just above the pinch point for a heat exchanger network synthesis problem. Propose all possible configurations which correspond to matches that split the fewest streams. Split a stream into at most two branches **06**

Stream	*FCp*
H1	10
H2	6
H3	1
C1	9
C2	7
C3	2

(b) Explain the algorithm with suitable example for automatic derivation of network structure for sequential HENS problem. **06**

OR

(b) "No heat should pass across the pinch for the minimum utility consumption design" Justify with example. **06**

Q-3 **(a)** Given the flow and composition for the top product list out the steps for method of plotting inter-cooling and inter-heating temperature curve. What information is available from that curve? **06**

(b) Discuss heat flows in side-strippers and side-enrichers with TQ diagram and compare it with conventional separation in sequential columns. **06**

OR

Q-3 **(a)** Explain Impact of Operating pressure on Heat Integrated Distillation Trains and discuss Multi-effect Distillation. **06**

(b) Explain Heat Pumping, Vapour Recompression and Reboiler Flashing configurations for increasing thermodynamic efficiency of distillation columns. **06**

Q-4 Based on the information for the streams and utilities given below, estimate the fewest number of heat exchangers needed if heat is not allowed to flow through pinch. Use $\Delta T_m = 20$ ºK. **12**

Stream	T_{in} ºK	T_{out} ºK	FC_p kW/ºK
Liquid, H1	450	325	5
Liquid, H2	400	375	10
	375	374	1000
	374	330	18
Liquid, C1	310	350	8
Vapour, C2	370	460	15
Utilities:			
High Pressure Steam	500	500	
Low Pressure Steam	350	350	
Cooling Water	305	<325	

OR

Q-4 Compare Mass Exchanger Network Synthesis and Heat Exchanger Network Synthesis methods in detail with example. **12**

Q-5 **(a)** For the Heat Exchanger Network Synthesis (HENS) problem following stream information is available: **06**

Stream	T_{in} ºC	T_{out} ºC	FC_p kW/ºC
C1	60	180	3
C2	30	105	2.6
H1	180	40	2
H2	150	40	4

Write a model for minimum utility cost if H2-C1 are not allowed to exchange heat.

(b) Explain concentration interval method for mass integration with example. **06**

OR

Q-5 **(a)** For the Heat Exchanger Network Synthesis (HENS) problem following stream information is available: **06**

Stream	T_{in} ºC	T_{out} ºC	FC_p kW/ºC	h W/m^2 ºC
C1	60	180	300	600
C2	30	105	260	600
H1	180	40	200	700
H2	150	40	400	800
Steam	230	230		5000
CW	25	32		600

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

Q-5 **(b)** Explain GCC Curve for refrigeration cycle. Using GCC plot, justify with suitable example that adding cycles can save work required for refrigeration cycle. **06**

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