Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– I (New course)• REMEDIAL EXAMINATION – SUMMER 2015

Subject Code: 2711606 **Date:15/05/2015**

Subject Name: Energy and Mass Integration

Time: 10:30 am to 1:00 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)** What is stream splitting? Explain with example. **05**

(b) Discuss importance of composite curves, HCC in HENS. **05**

(c) Explain the concept of shifting composite hot curve to find out pinch point and minimum utilities. **04**

Q.2 **(a)** Explain optimum temperature driving force, æT_{opt} for design of heat exchanger network. Explain shortcut method to estimate it. **06**

(b) Discuss the effect of minimum temperature driving force, æT_m in HENS. **04**

(c) Explain the concept of multi effect distillation. **04**

OR

(c) Discuss preheating or cooling of feed for energy integration in distillation **04**

Q.3 Based on the information for the streams and utilities given below, estimate the fewest number of heat exchangers needed if heat can be exchanged across the pinch. Use æT_m = 20 ºK. **14**

Stream	T_{in} ºK	T_{out} ºK	FC_p kW/ºK
Liquid, H1	430	340	15
Liquid, C1	310	395	7
Vapour, C2	370	460	32
Utilities:			
High Pressure Steam	500	500	
Low Pressure Steam	350	350	
Cooling Water	305	<325	

⇨ **What will be the effect if heat is not allowed to flow through pinch?**

⇨ **Discuss the effect of changing the value of ΔT_m on network design.**

OR

Q.3 Determine minimum utility targets and formulate MILP problem for the minimum number of exchanger units for the hot and cold streams given below. **14**

	Fcp (MW/K)	T_{in} (°C)	T_{out} (°C)
H1	1.2	300	110
H2	2.1	440	190
C1	1.5	180	400
C2	1.7	100	260

Use æT_{min} = 10 °C

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

Stream	T_{in} ºK	T_{out} ºK	FC_p kW/ºK
Liquid, H1	430	340	15
Liquid, C1	310	395	7
Vapour, C2	370	460	32

Draw Hohmann / Lockhart Composite Curves and find out pinch point for æT_{min} = 30 K.

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

	Fcp (MW/ºK)	T_{in} (ºK)	T_{out} (ºK)
H1	1.8	450	350
H2	1.5	450	350
C1	1.3	320	400
C2	2.2	320	420

Heating Utility : 500 ºK, Cooling Utility : 300 ºK, æT_{min} = 30 ºK

OR

Q.4 **(a)** Compare the sequential optimization and simultaneous optimization approaches for HENS. **05**

(b) Find out pinch point temperature for the following stream information using æT_{min} = 15 ºK: **09**

	Fcp (MW/K)	T_{in} (°C)	T_{out} (°C)
H1	2.4	590	350
H2	1.5	470	200
C1	1.6	200	500
C2	1.6	150	430

Q.5 **(a)** Explain composite curve method for Mass Exchanger Network Synthesis. **07**

(b) 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 first column in a series of columns to separate a mixture of four hydrocarbons, C3 to C6 (C6 amount is large-about 65% in feed). **07**

OR

Q.5 **(a)** Explain the analogy of Heat Exchanger Network Synthesis and Mass Exchanger Network Synthesis. **07**

(b) Use of side stripper or enricher reduces net utility consumption as compared to conventional distillation. Validate the statement by explaining the process on TQ diagram with examples. **07**

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