Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2711606 **Date: 04/01/2016**

Subject Name: Energy & Mass Integration (EMI)

Time:2:30 pm to 5:00 pm **Total Marks: 70**

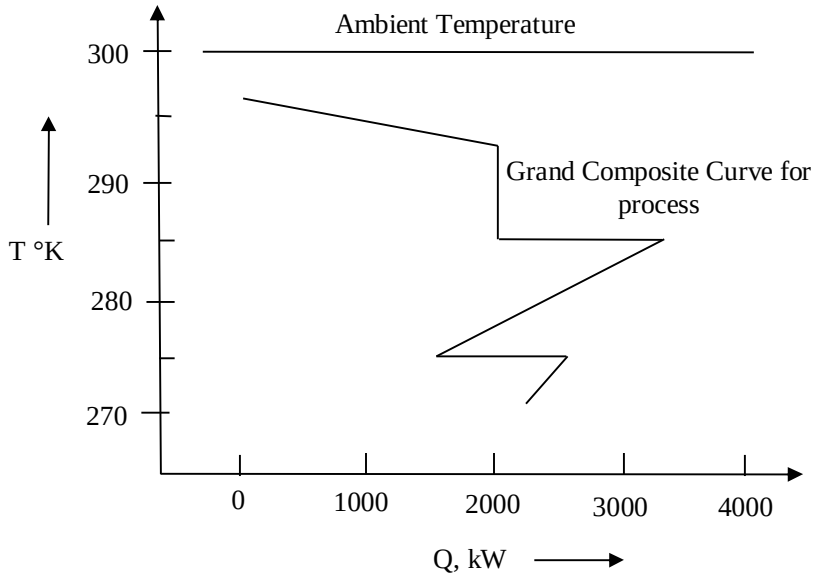
Instructions:

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

Q.1 **(a)** Explain the concept of Heat Pumping and discuss its strengths and weaknesses with a specific case study. **07**

(b) Explain the analogy of Heat Exchanger Network Synthesis and Mass Exchanger Network Synthesis. **07**

Q.2 **(a)** How many refrigeration cycles should you use for the following sub-ambient process? The grand composite curve (GCC) is based on a driving force of 2°K. The temperatures shown on the ordinate are cold-side temperatures. Indicate clearly why you have arrived at the answer you have. Using this example also discuss effect of adding more stage in your proposed solution. **07**



(b) Explain multi effect distillation with example. With TQ diagram explain how it can save energy. **07**

OR

(b) Use of side stripper reduces net utility consumption as compared to conventional distillation. Justify the statement with examples. **07**

Q.3 Determine the minimum utility consumption for the hot and cold streams given below using LP transshipment formulation for æT_{min} = 10 ºC. **14**

	FCp (kW/°C)	T_{out} (°C)	T_{in} (°C)
H1	3.60	100	430
H2	3.27	100	400
C1	2.80	390	150
C2	1.38	440	240
C3	3.36	520	150

Write a model for minimum utility cost if H2 and C1 are not allowed to exchange heat for the above HENS problem.

OR

Q.3 Determine minimum utility targets and formulate MILP problem for the minimum number of exchanger units. Use æT_{min} = 10 ºC. **14**

	FCp (kW/°C)	T_{out} (°C)	T_{in} (°C)
H1	3.60	100	430
H2	3.27	100	400
C1	2.80	390	150
C2	1.38	440	240
C3	3.36	520	150

Q.4 **(a)** Explain: How inter-cooling, inter-heating increases possibility of energy integration in distillation? **06**

(b) Determine the minimum utility consumption for the hot and cold streams given below using æT_{min} = 10 ºC. **08**

	Fcp (MW/K)	T_{in} (°C)	T_{out} (°C)
H1	5	350	200
H2	3	400	100
C1	6	200	400
C2	2	150	450

OR

Q.4 Draw HCC curve for the HENS data given here under and estimate average area of Heat Exchangers bellow and above pinch point. Use æT_{min} = 10 ºC. **14**

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

Q.5 **(a)** Justify: ñNo heat should pass across the pinch for the minimum utility consumption designò **05**

(b) Explain the concept of vapour recompression and reboiler flashing. Discuss their strengths and weaknesses with case study example. **09**

OR

Q.5 **(a)** What is stream splitting? Can stream splitting reduce number of exchanger units for HENS? Justify your answer with example. **05**

(b) A co-polymerization plant uses benzene as solvent. Benzene is to be recovered from its gaseous waste stream. Two lean steams in the process, an additive stream and a catalytic solution, are potential process MSAs. Organic oil, which can be regenerated using flash separation, is the external MSA. The stream data is as follows **09**

Stream	F (kmol/s)	y^s or x^s	y^t or x^t
R_1 (Off-gas)	0.2	0.0020	0.0001
L_1 (Additives)	0.08	0.003	0.006
L2 (Catalytic sol)	0.05	0.002	0.004
L_3 (Organic oil)	Unlimited	0.0008	0.0100

The equilibrium relation for Additives is : $y = 0.25x$, for Catalytic solution is : $y = 0.5x$ and for Organic oil is : $y = 0.1x$.

(a) Show how to utilize the process MSAs and minimize the amount of the external MSA required to remove benzene from rich stream. Use æx_{min} = 0.0002.

(b) Design the MEN.

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