Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (NEW) EXAMINATION – WINTER 2016

Subject Code: 2711606 **Date:06/01/2017**

Subject Name: Energy and Mass Integration

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)** Determine the minimum utility consumption for the hot and cold streams given below using LP transshipment formulation for ΔTmin = 10 ºC. **07**

Stream	FCp (kW/°C)	Tout (°C)	Tin (°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

(b) Discuss the importance of composite curves HCC and GCC in HENS. **07**

Q.2 **(a)** Explain how energy integration can be used to design refrigeration cycles. **07**

(b) For the Process given below in Fig 1draw hot composite curve , cold composite curve and combined composite curve. **07**

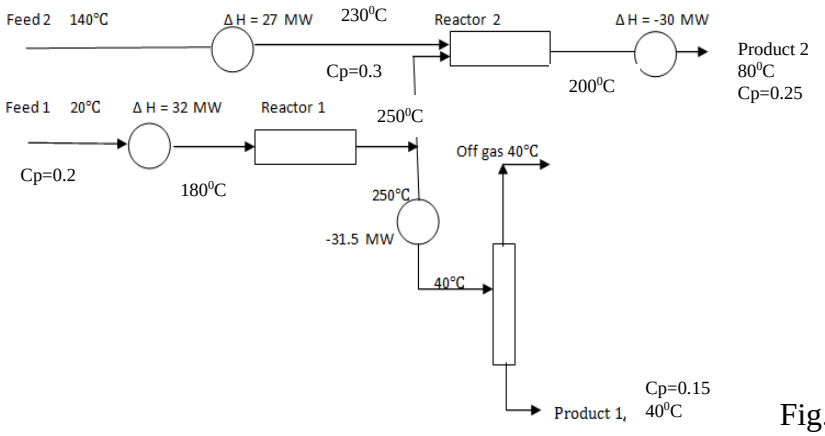

Fig. 1

OR

(b) Final grid diagram corresponding to the flow diagram of Fig.1 is shown below in Fig.2. Draw the final heat exchanger Network for the same.(Feed 2= Stream 3,Feed 1 = Stream 1) **07**

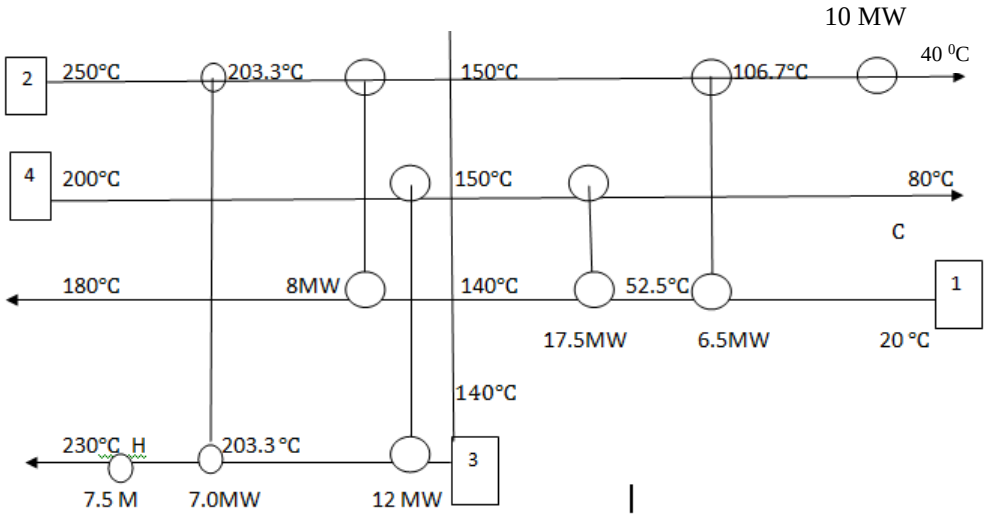

Fig. 2

Q.3 **(a)** Write the practical constraints restricting the options of Distillation sequencing. **07**

(b) For separation of three products, when middle product is not in excess, show the arrangement of separation when column can be operated at different pressures. **07**

OR

Q.3 **(a)** Discuss the Heuristic for the selection of the sequence for simple non-integrated distillation columns. **07**

(b) For separation of three products, when middle product is not in excess, show the arrangement of separation when column cannot be operated at different pressures (Pre-fractionator arrangement). **07**

Q.4 **(a)** Explain the analogy of Heat Exchanger Network Synthesis and Mass Exchanger Network Synthesis. **07**

(b) Justify: "No heat should pass across the pinch for the minimum utility consumption design" **07**

OR

Q.4 **(a)** Explain the concept of vapour recompression and reboiler flashing. **07**

(b) Explain the concept of multi effect distillation in detail with a neat diagram. **07**

Q.5 **(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
Liquid, H1	430	340	15
Liquid, C1	310	395	7
Vapour, C2	370	460	32

Formulate MILP model for minimum utility requirements. ΔT_{min} = 10 °C.

(b) Explain steps for pinch design approach to inventing a heat exchanger network. **07**

OR

Q.5 **(a)** Table below represents the data for a process . An evaporation process is to be integrated with the process. The evaporator is required to evaporate 1.77Kg/s water (latent heat = 2260 kJ/kg). Assuming ΔTmin = 10 ºC, suggest and outline evaporator configuration that will allow heat integration of the evaporator with the background process. **07**

Stream	T_s	T_t	ΔH(kW/ºK)
Hot	196	65	-10480
Hot	176	56	-12000
Hot	216	196	-2800
Hot	110	85	-2000
cold	90	180	11700
cold	40	120	12000

(b) For the process in Question 1, the stream and utility data are given in the table below. Pure counter current (1-1) shell and tube heat exchanger are to be used for ΔTmin = 10 ºC. **07**

a) Calculate the capital cost target if all individual heat exchangers can be costed by the relationship
Capital cost = 2,40,000 + 30000*A (Rs.)

Where A is the heat transfer area in sq. meter.

Stream	Supply temperature T_S (°C)	Target temperature T_T (°C)	ΔH (MW)	Heat capacity flowrate, CP (MW·K^{-1})	Film heat transfer coefficient, h (MW·m^{-2}·K^{-1})
1. Reactor 1 feed	20	180	32.0	0.2	0.0006
2. Reactor 1 product	250	40	−31.5	0.15	0.0010
3. Reactor 2 feed	140	230	27.0	0.3	0.0008
4. Reactor 2 product	200	80	−30.0	0.25	0.0008
5. Steam	240	239	7.5	7.5	0.0030
6. Cooling water	20	30	10.0	1.0	0.0010

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