

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER- VII (New) EXAMINATION – WINTER 2019

Subject Code: 2170507

Date: 30/11/2019

Subject Name: Computer Aided Process Synthesis

Time: 10:30 AM TO 01:00 PM

Total Marks: 70

Instructions:

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

MARKS

- Q.1**
- | | | |
|-----|--|-----------|
| (a) | Draw the superstructures for one cold stream and three hot streams. | 03 |
| (b) | Explain the 'process creation' step briefly in product and process design. | 04 |
| (c) | Calculate the number of possible sequences of ordinary distillation column for 10 number of product and draw only direct and indirect sequences. | 07 |

- Q.2**
- | | | |
|-----|---|-----------|
| (a) | Describe the criteria for selection of separation methods. | 03 |
| (b) | Explain marginal vapor rate method. | 04 |
| (c) | A given batch plant produces one single product for which stage 1 requires 8 hours/batch; stage 2, 4 hours/batch and stage 3, 7 hours/batch. If zero – wait transfer is used, what is the cycle time? How many parallel units should be placed in each stage to reduce the cycle time to 4 hours? | 07 |

OR

- (c) Write a short note on threshold approach temperature and optimum approach temperature for heat exchanger networks. **07**
- Q.3**
- | | | |
|-----|---|-----------|
| (a) | Describe the use of composite curves to select utility. | 03 |
| (b) | Write a note on Networks for Maximum Energy Recovery. | 04 |
| (c) | Draw the stream matching diagram above pinch temperature by considering pinch temperature in hot stream 125°C from the data given as follows. Assume $\Delta T_{\min} = 13^{\circ}\text{C}$. | 07 |

Stream	Source, $T_s (^{\circ}\text{C})$	Target, $T_t (^{\circ}\text{C})$	$MC_p (\text{kW}/^{\circ}\text{C})$
H1	175	45	10
H2	125	65	40
C1	20	155	20
C2	40	112	15

OR

- Q.3**
- | | | |
|-----|--|-----------|
| (a) | Calculate the minimum number of heat exchangers for heat exchanger network involving three different streams and two distinct utility sources. All the streams in process are connected directly or indirectly by heat exchangers. | 03 |
| (b) | Explain transshipment model for stream matching. | 04 |
| (c) | For, $\Delta T_{\min} = 20^{\circ}\text{C}$, using temperature interval method, find the minimum utility requirements and pinch point for a network of heat exchangers involving the following streams: | 07 |

Stream	Source, $T_s (^{\circ}\text{C})$	Target, $T_t (^{\circ}\text{C})$	$MC_p (\text{kW}/^{\circ}\text{C})$
H1	260	160	3
H2	250	130	1.5
C1	120	235	2
C2	180	240	4

- Q.4**
- | | | |
|-----|--|-----------|
| (a) | Write briefly on Role of computers in process synthesis. | 03 |
| (b) | Explain different Multiple Utility Design Problems in Heat Exchanger Networks. | 04 |

- (c) List the heuristics for determining favorable sequences of ordinary distillation columns and determine the best sequence for following problem: 07

Feed component	Feed rate, kmol/hr	Relative volatility	
		Component pair	Relative volatility
propane (C3)	45.4	C3/iC4	3.6
isobutene (iC4)	136.1	iC4/nC4	1.5
n-butane (nC4)	226.8	nC4/iC5	2.8
i-pentane (iC5)	181.4	iC5/nC5	1.35
n-pentane (nC5)	317.5		

OR

- Q.4** (a) Discuss the properties of residue curve map. 03
 (b) What are the residue curves? Draw the residue curves for a system containing octane, ethylbenzene and 2-ethoxyethanol with boiling point 398.8 K, 409.2 K and 408.1 K respectively. 2-ethoxyethanol makes binary azeotrope with octane and ethylbenzene at 389.1 K and 400.1K respectively. 04
 (c) Consider a plant consisting of two stages that manufactures two products A and B. Demands are 500000 kg/yr for A and 300000 kg/yr for B and the production time considered is 6000 hr. Data for processing time, size factors and cleanup times are as follows: 07

	Processing time (hr)		Size factors (m ³ /kg prod.)	
	Stage 1	Stage 2	Stage 1	Stage 2
A	8	3	0.08	0.05
B	6	3	0.09	0.04

Cleanup times: 4 hr A to B and B to A

The production schedule is single product campaigns and length of production cycle is 1000 hr. Perform the sizing of vessels for the plant.

- Q.5** (a) Define: Vapour Recompression and Reboiler Flashing 03
 (b) Discuss the concept of multi effect distillation as possibility of energy integration. 04
 (c) We have a mixture of five alcohols labeled as A, B, C, D and E with flows in the feed of 1, 0.5, 1, 7 and 10 mol/s respectively, for a total of 19.5 mol/s and relative volatilities are 4.3, 4, 3, 2, and 1 respectively. The information about marginal vapor flows estimated for non-key species are as under: 07

	A	B	C	D	E
A/B	--	--	2.6	6.5	3.2
B/C	5.3	--	--	9.3	4.0
C/D	2.4	1.3	--	--	6.7
D/E	1.5	0.8	2.0	--	--

Find the best distillation based separation sequence.

OR

- Q.5** (a) Explain the generalized rules for stream splitting on both sides of the pinch to satisfy MER requirements. 03
 (b) Define span and cycle time for batch processes. Explain various policies with example. 04
 (c) Given the processing times for these products A, B, C, below. Determine with a Gantt Chart the make span and cycle time for manufacturing two batches of A, 1 of B and 1 of C for the following cases. 07
 i. Zero-Wait policy with sequence AABC.
 ii. Same as i) but with no intermediate storage policy (NIC)
 iii. Same as i) but with unlimited intermediate storage policy (UIS)

(Processing Time)			
	Stage 1	Stage 2	Stage 3
A	5	4	3
B	3	1	3
C	4	3	2

Zero Cleanup Times
