

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VII (NEW) EXAMINATION – WINTER 2023****Subject Code:3170507****Date:01-12-2023****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.
4. Simple and non-programmable scientific calculators are allowed.

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|---|-----------|
| <b>Q.1</b> (a) For stream matching to be feasible at pinch, justify that $C_h \geq C_c$ must be satisfied on cold side of pinch.  | <b>03</b> |
| (b) Describe the criteria for selection of separation methods.  | <b>04</b> |
| (c) Discuss the pinch design approach for minimum utility requirements.   | <b>07</b> |
| <b>Q.2</b> (a) Differentiate between overlapping and non-overlapping operation.   | <b>03</b> |
| (b) Write a short note on environmental factors in process design.  | <b>04</b> |
| (c) Explain Vapor Recompression, Reboiler Flashing and Heat Pumping as an energy saving alternative for distillation along with their limitations.  | <b>07</b> |
| <b>OR</b>   |           |
| (c) For the stream data given in Table, Design heat exchanger network assuming $\Delta T_{\min}$ as 20°C. Hot pinch = 170°C, Cold pinch = 150°C $Q_{hu}=1000\text{MW}$ , $Q_{cu}=1180\text{MW}$ | <b>07</b> |

Stream	$T^s(^{\circ}\text{C})$	$T^t(^{\circ}\text{C})$	$mC_p(\text{MW}/^{\circ}\text{C})$
H <sub>1</sub>	260	140	18
H <sub>2</sub>	230	60	23
C <sub>1</sub>	60	220	21
C <sub>2</sub>	150	205	46

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|---|-----------|
| <b>Q.3</b> (a) Explain Significance of GCC Curve in Finding Minimum Utility Requirement.  | <b>03</b> |
| (b) Discuss the procedure for reactor network design using concept of attainable region.  | <b>04</b> |
| (c) Calculate the number of possible sequences of ordinary distillation column for 5 number of product and draw the sequences.  | <b>07</b> |
| <b>OR</b>   |           |
| <b>Q.3</b> (a) Explain node and saddle point in residue curve map.  | <b>03</b> |
| (b) Describe the use of grand composite curve to select utility   | <b>04</b> |
| (c) Define Residue curve. Construct 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. | <b>07</b> |
| <b>Q.4</b> (a) Compare forward heat integration and reverse heat integration in distillation with necessary figure.   | <b>03</b> |
| (b) Discuss design opportunities and steps in product and process design.   | <b>04</b> |
| (c) Write a short note on heuristics for designing separation processes.  | <b>07</b> |
| <b>OR</b>   |           |
| <b>Q.4</b> (a) Briefly describe role of computer programs useful in product and process design.   | <b>03</b> |
| (b) Discuss multi effect distillation as an energy saving alternative for separation along with their limitations.  | <b>04</b> |

- (c) Determine the minimum utility target for following stream data : Take  $\Delta T_{\min}=10^{\circ}\text{C}$

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Stream	$T^s(^{\circ}\text{C})$	$T^t(^{\circ}\text{C})$	$mC_p(\text{kW}/^{\circ}\text{C})$
<b>H<sub>1</sub></b>	260	160	3
<b>H<sub>2</sub></b>	250	130	1.5
<b>C<sub>1</sub></b>	120	235	2
<b>C<sub>2</sub></b>	180	250	4

- Q.5** (a) Write ethics of Chemical Engineers.

03

- (b) Define span and cycle time for batch processes. Explain various policies with example.

04

- (c) A mixture of four alcohols labeled as A, B, C, and D with flows in the feed of 1.05, 0.5, 1.2 and 7 mol/s respectively, for a total 9.75 mol/s and relative volatiles are 3.4, 2.5, 2 and 1 respectively. The information about marginal vapor flows estimated for non-key species are as under, Calculate number of possible sequence to separate four components. Find the best distillation based separation sequence.

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	A	B	C	D
A/B	--	--	2.53	3.59
B/C	3.11	--	--	5.6
C/D	1.88	1.25	--	--

**OR**

- Q.5** (a) Using TQ diagram justify energy saving in multi-effect distillation compared to the conventional distillation.

03

- (b) Draw the Gantt chart and calculate cycle time using following data: Consider zero wait transfer.

04

Task	1	2	3	4
Batch time,hr	2	6	4	3
Unit	U1	U2	U3	U4

- (c) Use the marginal vapor rate (MV) method to determine the sequence for the separation of light hydrocarbons. Give rank to various sequences.

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Sep.	MV	Sep.	MV	Sep.	MV	Sep.	MV	Sep.	MV
A/BCDE	12.3	ABC/DE	10.4	B/CDE	13.2	BCD/E	2.8	A/B	0
AB/CD	14	C/DE	6.7	B/CD	9.5	A/BC	2.6	B/C	0
AB/CDE	18.3	ABCD/E	4.3	BC/DE	8.2	A/BCD	9.1	C/D	0
ABC/D	3.6	CD/E	2.1	BC/D	1.3	AB/C	5.5	D/E	0

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