

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – WINTER 2021****Subject Code:3170507****Date:17/12/2021****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.

- Q.1** (a) Explain interior network and auxiliary network with a diagram. **03**
 (b) Write a short note on environmental factors in process design. **04**
 (c) Determine the minimum utility target for following stream data using temperature interval method: **07**

| Stream | T^{in} (K) | T^{out} (K) | mC_p (kW/K) |
|----------------|---------------------|----------------------|---------------|
| H ₁ | 650 | 370 | 10 |
| H ₂ | 590 | 370 | 20 |
| C ₁ | 410 | 650 | 15 |
| C ₂ | 353 | 500 | 13 |

Take $\Delta T_{\text{min}} = 10$ K.

- Q.2** (a) What is Gantt chart? Explain the importance of Gantt chart. **03**
 (b) 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? **04**
 (c) Discuss the pinch design approach for minimum utility requirements. **07**

OR

- (c) For the heat exchanger network synthesis (HENS) problem, the following stream information is available: **07**

| Stream | t^{in} (°C) | t^{out} (°C) | FC_p kW/°C |
|----------------|----------------------|-----------------------|--------------|
| C ₁ | 60 | 180 | 3 |
| C ₂ | 30 | 100 | 2 |
| H ₁ | 180 | 40 | 2 |
| H ₂ | 150 | 40 | 4 |

Draw HCC and find out pinch point for $\Delta T_{\text{min}} = 10$ °C.

- Q.3** (a) Discuss the engineering ethics briefly. **03**
 (b) Discuss in detail the phase separation of reactor effluent. **04**
 (c) Explain the concept of multi effect distillation as possibility of energy integration. **07**

OR

- Q.3** (a) Briefly explain safety considerations and design approaches towards safe chemical plant. **03**
 (b) Describe the use of grand composite curve to select utility. **04**
 (c) Explain the heat integration in distillation column using heat pumping, vapor recompression and reboiler flashing. **07**

- Q.4** (a) Draw the possible separation sequences for 4 number of products. **03**
 (b) Explain reactor design for complex configurations. **04**
 (c) With neat sketch explain positioning distillation towers between hot and cold composite curves. **07**

OR

- Q.4** (a) Define with example: cycle time, make span, flow shop plant. **03**
 (b) Explain in detail common industrial separation methods. **04**
 (c) Write a short note on threshold approach temperature and optimum approach temperature for heat exchanger networks. **07**
- Q.5** (a) Explain node and saddle point in residue curve map. **03**
 (b) Explain in brief general steps in product and process design. **04**
 (c) Given the processing time for two products A and B, determine makespan and cycle time for manufacturing one batch of A and one batch of B using i) zero wait policy, ii) no intermediate storage policy, and iii) unlimited intermediate storage policy. **07**

| | Processing Time (hr) | | |
|---|----------------------|---------|---------|
| | Stage 1 | Stage 2 | Stage 3 |
| A | 6 | 4 | 3 |
| B | 3 | 2 | 2 |

OR

- Q.5** (a) Draw the superstructure for one cold stream and two hot streams. **03**
 (b) Explain marginal vapor flows and show how it will be useful for predicting the best sequence of distillation columns. **04**
 (c) Write a short note on Geometric concepts for reactor attainable region. **07**

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – SUMMER 2022****Subject Code:3170507****Date:14/06/2022****Subject Name:Computer Aided Process Synthesis****Time:02:30 PM TO 05:00 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.

- Q.1** (a) Briefly describe computer programs useful in process design. **03**
 (b) Describe the use of grand composite curve to select utility. **04**
 (c) Explain Step by step Procedure for Construction of attainable region for Reactor design. **07**

- Q.2** (a) Explain separation sequencing for Solid-Fluid systems. **03**
 (b) Differentiate Flow shop plant and Job shop plant. **04**
 (c) Describe the environmental factors in process design. **07**

OR

- (c) Explain the positioning of heat pump with reference to pinch temperature. **07**
- Q.3** (a) Draw the superstructure for one cold stream and two hot streams. **03**
 (b) Explain the generalized rules for stream splitting on both sides of the pinch to satisfy MER requirements. **04**
 (c) The following five streams are to be cooled or heated. Find out pinch point and construct the Grand Composite Curve. Here $\Delta T_{\min} = 10^{\circ}\text{C}$ **07**

| STREAM | IN($^{\circ}\text{C}$) | OUT($^{\circ}\text{C}$) | $M_{cp}(\text{kW}/^{\circ}\text{C})$ |
|--------|--------------------------|---------------------------|--------------------------------------|
| H1 | 159 | 77 | 228.5 |
| H2 | 267 | 88 | 20.4 |
| H3 | 343 | 90 | 53.8 |
| C1 | 26 | 127 | 93.3 |
| C2 | 118 | 265 | 196.1 |

OR

- Q.3** (a) Derive the equation for construction of residue curve. **03**
 (b) Describe any four environmental factors to be considered in process design. **04**
 (c) For $\Delta T_{\min} = 20^{\circ}\text{C}$, find out pinch point and construct the Hohmann composite curve. Find out sink ($Q_{h\min}$) and source ($Q_{c\min}$). **07**

| STREAM | IN($^{\circ}\text{C}$) | OUT($^{\circ}\text{C}$) | $M_{cp}(\text{kW}/^{\circ}\text{C})$ |
|--------|--------------------------|---------------------------|--------------------------------------|
| H1 | 180 | 40 | 2 |
| H2 | 150 | 40 | 4 |
| C1 | 60 | 180 | 3 |
| C2 | 30 | 105 | 2.6 |

- Q.4** (a) Describe the criteria for selection of separation methods. **03**
 (b) Discuss the concept of multi effect distillation as possibility of energy integration. **04**

- (c) Given the processing times for two products A and B, determine makespan and cycle time for manufacturing one batch of A and one of B using (a) Zero wait policy (b) No intermediate storage policy (c) Unlimited intermediate storage policy. **07**

| Product | Stage-1 | Stage-2 | Stage-3 |
|---------|---------|---------|---------|
| A | 6 hrs | 4 hrs | 3 hrs |
| B | 3 hrs | 2 hrs | 2 hrs |

OR

- Q.4** (a) Explain the 'process creation' step briefly in product and process design. **03**
 (b) Define span and cycle time for batch processes. Explain various policies with example **04**
 (c) What is Gantt chart? Draw Gantt chart recipe AABC for zero wait transfer, No intermediate storage transfer and unlimited storage transfer policies from following processing times. **07**

| Product | Stage-1 | Stage-2 | Stage-3 |
|---------|---------|---------|---------|
| A | 5 hrs | 4 hrs | 3 hrs |
| B | 3 hrs | 1 hrs | 3 hrs |
| C | 4 hrs | 3 hrs | 2 hrs |

- Q.5** (a) What are the safety considerations in Process Design? **03**
 (b) Explain the concept of stream matching in Heat Exchanger Network. **04**
 (c) Use the marginal vapour rate (MV) method to determine a sequence for the separation of light hydrocarbons. Give rank to various sequences. **07**

| Separation | MV (kmol/hr) | Separation | MV (kmol/hr) |
|------------|--------------|------------|--------------|
| A/B | 0 | B/CD | 227 |
| A/BC | 163 | AB/CD | 435 |
| A/BCD | 340 | C/D | 0 |
| B/C | 0 | BC/D | 385 |
| AB/C | 231 | ABC/D | 613 |

OR

- Q.5** (a) "No heat passes across the pinch" Justify the Statement. **03**
 (b) Explain The Role of Computers in Process Design. **04**
 (c) Find the best distillation based separation sequence if the following data hold for marginal vapour flows. The components behave relatively ideally. **07**

| Separation | A | B | C | D | E |
|------------|---|-----|-----|---|---|
| A/B | - | - | 100 | 1 | 1 |
| B/C | 1 | - | - | 1 | 1 |
| C/D | 1 | 100 | - | - | 1 |
| D/E | 1 | 1 | 100 | - | - |
