

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VI (NEW) EXAMINATION – WINTER 2023****Subject Code:3163516****Date:07-12-2023****Subject Name:Introduction to Heat & Mass Transfer****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.

|            |                                                                                                                                                                                                                                                                                                                                                               | <b>MARKS</b> |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Q.1</b> | (a) What is Fourier's law of heat conduction?                                                                                                                                                                                                                                                                                                                 | <b>03</b>    |
|            | (b) Prove that For a sphere the average area of heat transfer is the geometric mean of inside and outside heat transfer areas.                                                                                                                                                                                                                                | <b>04</b>    |
|            | (c) Derive an expression for temperature distribution and heat distribution for heat flow through a cylinder.                                                                                                                                                                                                                                                 | <b>07</b>    |
| <b>Q.2</b> | (a) Discuss the concept of thermal boundary layer.                                                                                                                                                                                                                                                                                                            | <b>03</b>    |
|            | (b) What is meant by critical thickness of Insulation? Derive an expression for estimating critical thickness of Insulation of a cylinder?                                                                                                                                                                                                                    | <b>04</b>    |
|            | (c) A plate having 10 cm <sup>2</sup> area side is hanging in the middle of a room of 100 m <sup>2</sup> total surface area. The plate temperature and emissivity are respectively 800 K and 0.6. The temperature and emissivity values for the surfaces of the room are 300 K and 0.3 respectively. Find total heat loss from the two surfaces of the plate. | <b>07</b>    |
|            | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                     |              |
|            | (c) Discuss the physical significance of the following terms: (i) Prandtl number, (ii) Stanton number, (iii) Biot number, (iv) Grashof number (v) Peclet number (vi) Fourier number (vii) Nusselt number                                                                                                                                                      | <b>07</b>    |
| <b>Q.3</b> | (a) What is Leiden-frost mechanism?                                                                                                                                                                                                                                                                                                                           | <b>03</b>    |
|            | (b) What do you mean by thermal conductivity? Write in brief on its variation with temperature.                                                                                                                                                                                                                                                               | <b>04</b>    |
|            | (c) Discuss with relevant diagrams about forced convection boiling.                                                                                                                                                                                                                                                                                           | <b>07</b>    |
|            | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>Q.3</b> | (a) Explain the concept of black body. Explain in brief various laws of radiation                                                                                                                                                                                                                                                                             | <b>03</b>    |
|            | (b) Differentiate capacity and economy of evaporator.                                                                                                                                                                                                                                                                                                         | <b>04</b>    |
|            | (c) With the help of a neat sketch explain the working of 1-2 shell & tube heat exchanger and its important parts.                                                                                                                                                                                                                                            | <b>07</b>    |
| <b>Q.4</b> | (a) Write down the Fick's law with relevant equations.                                                                                                                                                                                                                                                                                                        | <b>03</b>    |
|            | (b) Mention the factors to be considered in selection of solvent in solvent extraction.                                                                                                                                                                                                                                                                       | <b>04</b>    |
|            | (c) Derive an expression for the logarithmic mean temperature difference in case of co-current flow double pipe heat exchanger.                                                                                                                                                                                                                               | <b>07</b>    |

**OR**

- Q.4** (a) What is Meir's super saturation theory? **03**  
(b) What are Non-Ideal solutions? Mention their relevant characteristics. **04**  
(c) The temperature of oil leaving a co-current flow cooler is to be reduced from 370 to 350 K by lengthening the cooler. The oil and water flow rates and inlet temperature and other dimensions of the cooler will remain constant. The water enters at 285 K and the oil at 420 K. The water leaves the original cooler at 310 K. If the original length is one meter, what must be the new length? **07**
- Q.5** (a) How Film theory predicts the relationship between mass transfer coefficient and diffusion coefficient? **03**  
(b) Write a short note on multicomponent distillation. **04**  
(c) Derive the time required for drying of a material in case of falling rate period between specific levels of moisture content. **07**
- OR**
- Q.5** (a) What do you mean by Extractive distillation? **03**  
(b) Prove that  $D_{AB}=D_{BA}$  **04**  
(c) With the help of neat diagram explain the working of Swenson Walker crystallizer. **07**

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