

**GUJARAT TECHNOLOGICAL UNIVERSITY**

**BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2018**

**Subject Code:2151909**

**Date:27/11/2018**

**Subject Name:Heat Transfer**

**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. Use of air table, steam table, heat exchanger chart is permitted.

**MARKS**

- |            |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |
|------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Q.1</b> | (a) | What is insulation? State its six applications in engineering field.                                                                                                                                                                                                                                                                                                                                                                              | <b>03</b> |
|            | (b) | It is observed that the intensity of the radiation emitted by the sun is maximum at a wavelength of $0.5 \mu$ . Assuming the sun to be black body. Calculate its surface temperature and emissive power.                                                                                                                                                                                                                                          | <b>04</b> |
|            | (c) | Saturated steam at $120^\circ\text{C}$ is condensing on the outer tube surface of a single pass heat exchanger. The overall heat transfer coefficient is $1800 \text{ W/m}^2 \text{ K}$ . Determines the surface area of a heat exchanger capable of heating $1000 \text{ kg/h}$ of water from $20^\circ\text{C}$ to $90^\circ\text{C}$ . Also calculate the rate of condensation of steam. Assume latent heat of steam is $2200 \text{ KJ/Kg}$ . | <b>07</b> |
| <b>Q.2</b> | (a) | What is dimensional analysis? Explain dimensional homogeneity.                                                                                                                                                                                                                                                                                                                                                                                    | <b>03</b> |
|            | (b) | A copper pipe (temperature $55^\circ\text{C}$ ) is kept in atmosphere (temperature $35^\circ\text{C}$ ). The length and diameter of pipe is $1\text{m}$ and $50 \text{ mm}$ respectively. The air velocity is $3 \text{ m/s}$ . use the co-relation $\text{Nu} = 0.0239 (\text{Re})^{0.805}$ . Calculate heat loss from the pipe.                                                                                                                 | <b>04</b> |
|            | (c) | Derive the two dimensional energy equation for thermal boundary layer over a flat plate.                                                                                                                                                                                                                                                                                                                                                          | <b>07</b> |
|            |     | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |
|            | (c) | By dimensional analysis, show that for forced convection Nusselt Number is a function of Reynold Number and Prandtl Number.                                                                                                                                                                                                                                                                                                                       | <b>07</b> |
| <b>Q.3</b> | (a) | Explain film wise condensation.                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>03</b> |
|            | (b) | Emissivity of two large parallel plates maintained at $800^\circ\text{C}$ and $300^\circ\text{C}$ are $0.3$ and $0.5$ respectively. Find the net radiant heat exchange per square meter for these plates.                                                                                                                                                                                                                                         | <b>04</b> |
|            | (c) | Derive equation of net heat transfer by radiation between two infinite parallel plates.                                                                                                                                                                                                                                                                                                                                                           | <b>07</b> |
|            |     | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |
| <b>Q.3</b> | (a) | Define shape factor. What is shape factor with respect to itself if the surface is concave, convex or flat?                                                                                                                                                                                                                                                                                                                                       | <b>03</b> |
|            | (b) | Differentiate between 1. Subcooled and saturated boiling 2. Nucleate and film boiling                                                                                                                                                                                                                                                                                                                                                             | <b>04</b> |
|            | (c) | State and prove Kirchhoff's law of radiation. Derive Wein's displacement law.                                                                                                                                                                                                                                                                                                                                                                     | <b>07</b> |

|            |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |
|------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Q.4</b> | (a) | What is difference between heat transfer and thermodynamics?                                                                                                                                                                                                                                                                                                                                                                                              | <b>03</b> |
|            | (b) | What is fouling? State the causes of fouling.<br>State the limitations of LMTD method. What is heat pipe?                                                                                                                                                                                                                                                                                                                                                 | <b>04</b> |
|            | (c) | Derive equation of LMTD for counter flow heat exchanger.                                                                                                                                                                                                                                                                                                                                                                                                  | <b>07</b> |
| <b>OR</b>  |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |
| <b>Q.4</b> | (a) | Which are the basic laws governing the heat transfer. State any one.                                                                                                                                                                                                                                                                                                                                                                                      | <b>03</b> |
|            | (b) | What is compact, multipass and regenerator type heat exchanger? State six application of heat exchanger in the field of engineering.                                                                                                                                                                                                                                                                                                                      | <b>04</b> |
|            | (c) | Derive equation of effectiveness for parallel flow heat exchanger.                                                                                                                                                                                                                                                                                                                                                                                        | <b>07</b> |
| <b>Q.5</b> | (a) | What is Fourier's law of heat conduction? State its assumptions.                                                                                                                                                                                                                                                                                                                                                                                          | <b>03</b> |
|            | (b) | A steel pipe ( $k = 35 \text{ W/m K}$ ) with inner diameter 50 mm and outer diameter 60 mm is insulated using insulation material having ( $K = 0.055 \text{ W/m.K}$ ). The temperature interface between pipe and insulation is 573 K, while the temperature on outside of insulation must not exceed 343 K, with permissible heat loss of 700 W/m. calculate (1) the minimum thickness of insulation and (2) the temperature of inside surface of pipe. | <b>04</b> |
|            | (c) | Derive expression for temperature distribution and heat dissipation in a straight infinitely long fin of rectangular profile.                                                                                                                                                                                                                                                                                                                             | <b>07</b> |
| <b>OR</b>  |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |
| <b>Q.5</b> | (a) | Define fin efficiency. Explain the situation, when addition of fin to a surface is not useful.                                                                                                                                                                                                                                                                                                                                                            | <b>03</b> |
|            | (b) | A steel rod ( $K = 54 \text{ W/m}^\circ \text{K}$ ) with a cross section of an equilateral triangle (each side 5 mm) is 80 mm long. It is attached to a furnace wall which is maintained at a temperature of $400^\circ \text{C}$ . The surrounding is at $50^\circ \text{C}$ and surface conductance is $90 \text{ W/m}^2 \text{K}$ . Calculate the heat dissipated by the rod. Assume tip of the rod is insulated.                                      | <b>04</b> |
|            | (c) | Derive expression for temperature distribution, under one dimensional steady state heat conduction for the hollow cylinder.                                                                                                                                                                                                                                                                                                                               | <b>07</b> |

\*\*\*\*\*