

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER– VII (NEW) EXAMINATION – WINTER 2021****Subject Code:2170102****Date:25/11/2021****Subject Name:Theory of Heat 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.
5. Tables for properties of air and water are permitted.

Q.1 (a) Distinguish between the conduction, convection and radiation modes of heat transfer with suitable example. **03**

(b) Define the following: **04**
 (a) Fin Efficiency (b) Fin Effectiveness

(c) Air at 20⁰C flows across an elliptical tube 60 mm x 120 m, perpendicular to the minor axis with a velocity of 2.8 m/s. The surface of tube is maintained at 60⁰C. Determine the value of convection coefficient. **07**

Use the following relation:

$$Nu = 0.224 \times (Re)^{0.612} \times (Pr)^{0.33}$$

The thermo-physical properties at mean film temperature are as follows:

$$k = 0.0265 \text{ W/m-K}, Pr = 0.71, \nu = 17.6 \times 10^{-6} \text{ m}^2/\text{s}$$

Q.2 (a) What do you mean by transient analysis? Define Biot Number? **03**

(b) Derive critical radius of insulation $r_c = k / h_o$ **04**

(c) A steam pipe is covered with two layers of insulation, first layer being 3 cm thick and second 5 cm. The pipe is made from steel ($k = 58 \text{ W/m}^0\text{C}$) having ID of 160 mm and OD of 170 mm. The inside and outside film coefficients are 30 and 5.8 $\text{W/m}^2 \text{ }^0\text{C}$, resp. Draw electrical analogy for system and calculate the heat lost per meter of pipe, if the steam temperature is 300⁰C and air temperature is 50⁰C The thermal conductivity of two materials is 0.17 and 0.093 $\text{W/m}^0\text{C}$, respectively. **07**

OR

(c) One end of a long rod 0.03 m in diameter is inserted into a furnace with the outer end projecting into the outside air. Once the steady state is reached the temperature of the rod is measured at two points, 0.15 m apart and found to be 140⁰C and 100⁰C, when the ambient air is at 30⁰C with convection coefficient of 20 $\text{W/m}^2\text{.K}$. Calculate the thermal conductivity of the rod material. **07**

Q.3 (a) What is transient heat transfer? How it is different from steady state heat transfer? **03**

(b) Differentiate between Natural and forced convection. **04**

(c) Derive an energy equation for thermal boundary layer over a flat plate? 07

OR

Q.3 (a) Define Grashoff Number. Explain its significance in convection heat transfer. 03

(b) Define the following: 04

(a) Boundary Layer Thickness (b) Displacement Thickness

(c) Momentum Thickness (d) Energy Thickness

(c) Explain the various regimes of pool boiling with a neat sketch? 07

Q.4 (a) Define heat exchanger? Classify heat exchanger in detail? 03

(b) Explain Film and dropwise condensation with neat sketch? 04

(c) Prove that the effectiveness of counter flow heat exchanger is given by 07

$$\varepsilon = \frac{1 - \exp[-NTU(1-C)]}{1 - C \exp[-NTU(1-C)]}$$

OR

Q.4 (a) Write a note on fouling factor? 03

(b) Define heat exchanger? Classify heat exchanger in detail? 04

(c) Derive an expression for logarithmic mean temperature difference (LMTD) in the case of parallel flow heat exchanger. 07

Q.5 (a) Explain concept of a black body? 03

(b) Define following: 04

1) Absorptivity

2) Emissivity

3) Spectral Intensity of Radiation

4) Total Emissivity

(c) Explain the following: 07

(i) Wien's displacement law

(ii) Radiation Shield

(iii) Geometrical factor

OR

Q.5 (a) Explain the following : 03

a) Solid angle b) Radiosity c) Black body

(b) Prove that the intensity of radiation is given by $I_b = E_b / \pi$ 04

(c) Derive an expression for shape factor in case of radiation exchange between two surfaces. 07
