Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2022

Subject Code:2170102 Date:05-01-2023

Subject Name:Theory of 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. **Simple and non-programmable scientific calculators are allowed.**
5. **Tables for properties of air and water are permitted.**

Q.1 **(a)** Explain Fourier's law of heat conduction. **03**

(b) Define Fin. Also classify the fins in detail. **04**

(c) Air stream at 24^0C is flowing at 0.4 m/s across a 100 W bulb at 130^0C. If the bulb is approximated by a 65 mm diameter sphere, calculate: **07**

(1) The heat transfer rate

(2) The percentage of power lost due to convection.

Using the relation: $Nu=0.37\ Re^{0.6}$

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

k= 0.03 W/m-K,Pr= 0.707, $\upsilon = 2.08 \times 10^{-5}$ m^2/s

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

(b) "It is true that insulation is provided to reduce heat transfer rate but due to insulation heat transfer rate is not reduced always" Justify the statement analytically. **04**

(c) A wall of furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperature at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725^0C and 110^0C respectively. The contact thermal resistance between the two walls at the interface is 0.0035^0C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are 1.7 Wm-K and 5.8 W/m-K , Calculate **07**

(1) The rate of heat loss per unit area of walls and

(2) The temperature drop at the interface.

OR

(c) A very long 25 mm diameter copper (k= 380 W/m-K) rod extends from a surface at 120^0C. The temperature of surrounding air is 25^0C and the heat transfer coefficient over the rod is 10 W/m^2 K. Calculate: **07**

(1) Heat lost from the rod

(2) How long the rod should be in order to be considered infinite?

Q.3 **(a)** What is lumped system analysis? What are the assumptions and when is it applicable? **03**

(b) Explain Free and forced convection heat transfer with suitable example. **04**

(c) Explain the various parameters used in the free convection. Using Dimensional Analysis, obtain an expression for Nusselt Number in terms of Gr& Pr. **07**

OR

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

(b) What do you mean by Dimensional analysis? What are the assumptions used in it? **04**

(c) A vertical plate 0.4 m high and 0.41 m wide at 50°C is exposed to steam at 100°C. Calculate the following (a) Film thickness at bottom of the plate (b) Maximum velocity at the bottom of the plate (c) Total heat transfer rate and heat flux. Assume at mean temperature of 75°C. **07**

ρ = 976 kg/m^3, k = 0.668 W/m-K, μ=405 x10^{-6} kg/ms, h_{fg} = 2258 kJ/kg

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

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

(c) Prove that the effectiveness of parallel flow heat exchanger is given by $\varepsilon = \frac{1-\exp[-NTU(1+C)]}{1+C}$ **07**

OR

Q.4 **(a)** Explain NTU and Effectiveness of heat exchanger? **03**

(b) Explain correction factor for multi-pass arrangement heat exchanger? Also define fouling factor? **04**

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

Q.5 **(a)** State & explainLambert's cosine law. **03**

(b) Define following: **04**
1) Total Emissivity
2) Emissivity
3) Radiosity
4) Absorptivity

(c) Two parallel rectangular surfaces 1m x 2m are opposite to each other at a distance of 4 m. The surfaces are black and at 100°C and 200 °C. Calculate the heat exchange by radiation between the two surfaces? **07**

OR

Q.5 **(a)** Explain the following : **03**

a) Solid angle
b) Spectral Intensity of Radiation
c) Black body

(b) Define Radiation shield and Radiation geometrical factor. **04**

(c) Derive an expression for rate of radiation exchange, when a radiation shield is inserted between two large parallel plates. **07**

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