

GUJARAT TECHNOLOGICAL UNIVERSITY**BE – SEMESTER- VII EXAMINATION-SUMMER 2023****Subject Code: 2170102****Date: 28/06/2023****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) Define Fin. Also classify the fins in detail. **03**
- (b) Explain the Fourier law of conduction. **04**
- (c) A wall is constructed of several layers. The first layer consists of brick ($k = 0.66 \text{ W/m.K}$), 25 cm thick, the second layer 2.5 cm thick mortar ($k = 0.7 \text{ W/m.K}$), the third layer 10 cm thick limestone ($k = 0.66 \text{ W/m.K}$) and outer layer of 1.25 cm thick plaster ($k = 0.7 \text{ W/m.K}$). The heat transfer coefficients on interior and exterior of the wall fluid layers are $5.8 \text{ W/m}^2.\text{K}$ and $11.6 \text{ W/m}^2.\text{K}$, respectively. **07**
- Find : (i) Overall heat transfer coefficient,
(ii) Overall thermal resistance per m^2 ,
(iii) Rate of heat transfer per m^2 , if the interior of the room is at 26°C while outer air is at -7°C ,
iv) Temperature at the junction between mortar and limestone.

- Q.2** (a) Define insulation? Derive critical radius for cylinder? **03**
- (b) What do you mean by unsteady state heat transfer analysis? Also define Fourier and Biot Number? **04**
- (c) Derive general heat conduction equation in Cartesian coordinates. **07**

OR

- (c) Prove that fully developed flow in a tube subjected to constant surface heat flux, the temperature gradient is independent of x and thus the shape of the temperature profile does not change along the tube. **07**
- 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) Derive equations of temperature distribution and heat dissipation for finite fin. **07**

OR

- Q.3** (a) Explain the following terms: **03**
- (1) Nusselt Number. (2) Prandtl number (3) Grashoff number.

- (b) Explain thermal and velocity boundary layer with a neat sketch? 04
- (c) Explain the dimensional analysis. Using Dimensional Analysis, obtain an expression for forced convection. 07
- Q.4** (a) Differentiate parallel flow and counter flow heat exchanger. 03
- (b) With a neat sketch explain Film and dropwise condensation. 04
- (c) Derive an expression for logarithmic mean temperature difference (LMTD) in the case of parallel flow heat exchanger. 07
- OR**
- Q.4** (a) State & explain Lambert's cosine law. 03
- (b) Explain the following terms in heat exchanger? 04
(1) Effectiveness (2) NTU
- (c) Prove that the effectiveness of parallel flow heat exchanger is given by 07

$$\varepsilon = \frac{1 - \exp[-NTU(1+C)]}{1+C}$$
- Q.5** (a) Write a short note on fouling factor? 03
- (b) Define following: 04
 1) Grey body
 2) Black body
 3) Emissivity
 4) Radiosity
- (c) Define total emissive power (E_b) and intensity of radiation (I_b). Show that 07
 $E_b = \pi \times I_b$
- OR**
- Q.5** (a) Explain the following : 03
 a) Solid angle
 b) Spectral Intensity of Radiation
 c) Black body
- (b) Explain the following terms: 04
 (1) Radiation shield (2) Radiation geometrical factor.
- (c) Derive an expression for rate of radiation exchange, when a radiation shield is inserted between two large parallel plates. 07
