

# GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VII (NEW) EXAMINATION – WINTER 2024

Subject Code:2170102

Date:07-12-2024

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 Extended Surface. Also, write classifications of the fins. **03**  
(b) Write a note on Fourier's law of heat conduction. **04**  
(c) In an air conditioned room, the wall of the house measures 2 m x 6 m. It consists of 1 cm thick wood paneling of thermal conductivity 0.06 W/mK and 20 cm thick concrete wall having the thermal conductivity of 1.2 W/mK. The inside temperature is maintained at 25<sup>0</sup>C and the atmospheric temperature is 40<sup>0</sup>C. Find the gain of heat transfer rate by the room and the temperature at interface of wood and concrete wall. **07**
- Q.2** (a) Write temperature profile equation and heat transfer from fin for **03**  
1) Infinite long fin  
2) Tip insulated fin  
3) Tip non-insulated fin  
(b) Define insulation? Explain economic thickness of insulation. **04**  
(c) Derive general heat conduction equation in Cartesian coordinates. **07**
- OR**
- (c) The engine of an automobile can be considered as a box of length of 0.7 m, width 0.23 m and height 0.1 m. Its surface temperature is maintained at 60<sup>0</sup>C. When the automobile moves at a velocity of 30 m/s, the air at 20<sup>0</sup>C passes over the crankcase at relative speed. Assuming the flow to be turbulent with  $Nu_L = 0.036 Re_L^{0.8} Pr^{1/3}$ , find the rate of heat transfer from all sides of the crankcase. **07**  
Take:  $\rho = 1.09 \text{ kg/m}^3$ ,  $\nu = 20.1 \times 10^{-6}$ ,  $k = 0.07 \text{ W/mK}$ ,  $Pr = 0.7$
- Q.3** (a) State and Explain: **03**  
(1) Efficiency of fins  
(2) Effectiveness of fins  
(b) Differentiate between Natural and Forced convection heat transfer with suitable examples. **04**  
(c) Using dimensional analysis, obtain a general form of equation for forced Convective heat transfer. **07**
- OR**
- Q.3** (a) Define Nusselt Number. Explain its significance in convection heat transfer. **03**  
(b) Differentiate: **04**  
1. Mean film temp and bulk mean temp  
2. Velocity and thermal boundary layer  
(c) Define critical thickness? Explain critical radius for cylinder? **07**

- Q.4 (a)** Write classification of heat exchanger in detail? **03**
- (b)** Explain Film and drop-wise condensation with suitable diagram? **04**
- (c)** Explain mechanism of nucleate boiling with neat sketch? **07**
- OR**
- Q.4 (a)** Explain NTU and Effectiveness of heat exchanger? **03**
- (b)** Explain correction factor and 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)** Explain Kirchhoff's law of radiation? **03**
- (b)** Define following: **04**  
 1) Total Emissivity 2) Emissivity 3) Radiosity 4) Absorptivity
- (c)** What are the radiation surface and space resistances? How are they expressed? For what kind of surface, is radiation surface resistance zero? **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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