Graphic Era
HILL UNIVERSITY
Established by an Act of the State Legislature of Uttarakhand (Adhiniyam Sankhya 12 of 2011)
University under section 2(f) of UGC Act, 1956

Term Evaluation (Odd) Semester Examination September 2025

Roll no............................

Name of the Course: **B.TECH** (ME)
Semester: 5th
Name of the Paper: **HEAT TRANSFER**
Paper Code: **TME 501**
Time: 1.5 hour **Maximum Marks: 50**

Note:
(i) Answer all the questions by choosing any one of the sub-questions
(ii) Each question carries 10 marks.

Q1. **(10 Marks)**

a. Explain the three modes of heat transfer with examples. Write their governing laws. **CO 1**

OR

b. A solid copper sphere of 10 cm diameter [$\rho = 8954$ kg/m³, $c_p = 383$ J/kg.K, $k = 385$ W/m.K], initially at a uniform temperature $t_i = 250°C$, is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature $t_a = 50°C$. The heat transfer coefficient between the sphere and the fluid is $h = 200$ W/m².K. Determine the temperature of the copper block at $\tau = 5$ min after the immersion. **CO 1**

Q2. **(10 Marks)**

a. Derive the expression for the overall heat transfer coefficient for a composite wall with three layers. **CO 1**

OR

b. Explain the concept of the critical radius of insulation for a cylindrical pipe. Derive the formula for the critical radius and discuss its significance in heat transfer. Why does increasing insulation thickness beyond the critical radius decrease heat loss? **CO 1**

Q3. **(10 Marks)**

a. Define fins and explain their importance in heat transfer. Give at least four practical applications. **CO 2**

OR

b. Determine the rate of heat flow through a spherical boiler wall which is 2 m in diameter and 2 cm thick steel ($k = 58$ W/m.K). The outside surface of the boiler wall is covered with asbestos ($k = 0.116$ W/m.K) 5 mm thick. The temperature of the outer surface and that of the fluid inside are 50°C and 300°C respectively. Take inner film resistance as 0.0023 K/W. **CO 1**

Q4. **(10 Marks)**

a. Derive the temperature distribution and heat dissipation formula for a short fin with insulated tip. **CO 2**

OR

b. A steam pipe ($k = 45$ W/m°C) having 70 mm inside diameter and 85 mm outside diameter is lagged with two insulation layers; the layer in contact with the pipe is 35 mm asbestos ($k = 0.15$ W/m°C) and it is covered with 25 mm thick magnesia insulation ($k = 0.075$ W/m°C). The heat transfer coefficients for the inside and outside surfaces are 220 W/m^2°C and 6.5 W/m^2°C respectively. If the temperature of steam is 350°C and the ambient temperature is 30°C, calculate:

(i) The steady loss of heat for 50 m length of the pipe.

(ii) The overall heat transfer coefficients based on inside and outside surfaces of the lagged steam main.

CO 1

Q5. **(10 Marks)**

a. A straight fin of length 100 mm, thickness 5 mm, and thermal conductivity 200 W/m·K is exposed to air at 25 °C. The base temperature is 125 °C and heat transfer coefficient is 20 W/m^2·K. Assuming insulated tip, calculate the heat dissipated by the fin. **CO 2**

OR

b. Derive the expressions for fin efficiency and fin effectiveness. Discuss their importance in fin design.

CO 2