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	5E1719	
	B.Tech. V - Sem. (Main & Back) Examination, November/December-2025	
	Automobile Engg. 5AE4-02 Heat Transfer AE, ME	
Time : 3 Hours		Maximum Marks : 70

Instructions to Candidates:

*Attempt **all Ten** questions from **Part A**, **five** questions out of **Seven** questions from **Part B** and **Three** questions out of **Five** questions from **Part C**.*

Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

*Use of following supporting material is permitted during examination.
(Mentioned in form No. 205).*

PART - A

(Answer should be given up to 25 words only)

ALL questions are Compulsory.

(10×2=20)

1. State Fourier's law of heat conduction .
2. Define thermal conductivity.
3. What do you understand by critical radius of insulation?
4. Define fin effectiveness.
5. Define the Biot number and its physical significance.
6. Define the hydrodynamic boundary layer and thermal boundary layer over a flat plate.
7. Define the Grashof number and explain its significance in natural convection.
8. Differentiate between nucleate boiling and film boiling
9. What is NTU in heat exchangers?
10. State Kirchhoff's law of radiation.

PART - B

(Analytical/Problem Solving Questions)

Attempt any FIVE questions.

(5×4=20)

1. A cylindrical rod, length 0.5 m and cross-sectional area $2 \times 10^{-4} \text{ m}^2$, is made of a material with thermal conductivity $k = 15 \text{ W/m.K}$. Its ends are maintained at 100°C and 25°C . Calculate the rate of heat conduction through the rod.
2. Explain how to determine the critical thickness of cylindrical insulation for minimal heat loss.
3. Derive the expression for fin efficiency for an insulated tip fin of rectangular profile.
4. In a parallel - flow heat exchanger, hot fluid enters at 120°C and leaves at 80°C . Cold fluid enters at 30°C and leaves at 60°C . Determine the LMTD.
5. Explain the various regimes of pool boiling and sketch the typical boiling curve.
6. Differentiate between black body and grey body. Also define emissivity.
7. Explain Planck's law and Wien's displacement laws along with their mathematical expressions?

PART - C

(Descriptive/Analytical/Problem Solving/Design Questions)

Attempt any THREE questions.

(3×10=30)

1. Derive the general three-dimensional steady state heat conduction equation with heat generation in cartesian coordinates.
2. A rectangular fin of length 5 cm and cross-section $5 \text{ mm} \times 5 \text{ mm}$ is attached to a wall maintained at 150°C . Ambient air is at 25°C and $h = 40 \text{ W/m}^2 \cdot \text{K}$. $k = 200 \text{ W/m.K}$. Calculate heat transfer and fin efficiency assuming the fin tip is insulated.
3. Explain the difference between natural and forced convection. Derive the expression for the local and average convective heat transfer coefficient over a flat plate using boundary layer theory.
4. Hot oil flows at 2 kg/s ($c_p = 2.5 \text{ kJ/kg.K}$) and is cooled from 180°C to 130°C in a counter-flow heat exchanger. Water enters at 20°C at 1.5 kg/s ($C_p = 4.18 \text{ kJ/kg.K}$). Calculate the rate of heat transfer, outlet temperature of water, and effectiveness using the NTU method.
5. Explain the concept of view factor (shape factor) and its governing rules. Derive and illustrate the reciprocity and summation rules with examples.