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Course Code

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Sixth Semester B.E. Degree Examinations, May/June 2025

HEAT TRANSFER

Duration: 3 hrs

Max. Marks: 100

- Note:**
1. Answer any FIVE full questions, choosing ONE full question from each module.
 2. Use of Heat Transfer Handbook is permitted.
 3. Missing data, if any, may be suitably assumed

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO: PI)</u>
<u>Module-1</u>			
1.	a. Derive an expression for general three dimensional heat conduction equation in Cartesian coordinate.	10	(2 :1: 1.6.1)
	b. A surface of 1.6 m ² area which is maintained at 250 °C exchanges heat by radiation with another surface at 45 °C, having $\epsilon=0.45$. Calculate the heat lost by radiation	04	(3 :1: 1.7.1)
	c. State the following with respective equations (i) Fourier's Law of Heat Conduction (ii) Newton's law of heating or cooling (iii) Kirchoff's Law	06	(1 :1: 1.6.1)
(OR)			
2.	a. A wall of a furnace is made up of an inside layer of silica brick 120 mm thick covered with a layer of magnesite brick of 240 mm thick. The temperatures at the inside surface of silica brick and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If the thermal conductivities of silica and magnesite bricks are 1.7 W/m°C and 5.8 W/m°C , calculate (i) The rate of heat loss per unit area of the walls and (ii) The temperature drop at the interface	10	(3 :1: 1.7.1)
	b. With neat sketch, explain the factors on which heat transfer coefficient depends.	10	(2 :1: 1.6.1)
<u>Module-2</u>			
3.	a. With neat sketches, list the common type of fin configurations.	04	(1 :2: 1.6.1)
	b. Define fin efficiency and fin effectiveness with equation.	06	(1 :2: 1.6.1)
	c. A long 25 mm diameter copper rod ($k=380\text{W/m}^\circ\text{C}$) extends horizontally from a plane heated wall at 120°C. The temperature of the surrounding air is 25°C and the convective heat transfer coefficient is 9 W/m ² °C. (i) Determine the heat loss (ii) How long the rod be in order to be considered infinite	10	(3 :2: 1.7.1)
(OR)			
4.	a. Define (i) unsteady state heat transfer (ii) Thermal time constant (iii) Biot number (iv) Fourier number (v) characteristic length	10	(1 :2: 1.6.1)
	b. A 130 mm diameter apple ($\rho=990\text{ kg/m}^3, c=4166\text{J/kg }^\circ\text{C}, k=0.6\text{W/m }^\circ\text{C}$), approximately spherical in shape is taken from a 22 °C atmospheric conditions and placed in a freezer where temperature is 5°C and heat transfer coefficient over the apple surface is 13.2W/m ² °C. Determine the temperature at the centre of the apple after a duration of 1.5 hours.	10	(3 :2: 1.6.1)

Module-3

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| 5. | a. Explain formulation of differential equation 1-D steady state heat conduction. | 10 | (2 :3: 1.6.1) |
| | b. Explain explicit scheme of a solution to one-dimensional transient heat conduction problem without heat generation. | 10 | (2 :3: 1.6.1) |

(OR)

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| 6. | a. Define (i) Total Emissive Power (ii) Monochromatic Emissive Power (iii) Emissivity (iv) Regular Reflection (v) Diffuse Reflection | 10 | (1 :3: 1.6.1) |
| | b. Calculate the following for an Industrial furnace in the form of a Black body and emitting radiation at 2500 °C
(i) Monochromatic Emissive Power at 1.2 μm length (ii) Wavelength at which the emission is maximum (iii) Maximum emissive power
(iv) Total Emissive Power (v) Total emissive power of the furnace if it is assumed as real surface with emissivity equal to 0.9 | 10 | (3 :3: 1.6.1) |

Module-4

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| 7. | a. Define
(i) Boundary layer thickness (ii) Drag force
(iii) Leading edge (iv) Trailing Edge | 06 | (1 :4: 1.6.1) |
| | b. Lubricating oil at a temperature of 60°C enters at 1cm diameter tube with a velocity of 3.5m/s and a tube surface is maintained at 30 °C. Calculate the tube length required to cool the oil to 45°C. Assume the oil has following average properties.
$\rho=865\text{kg/m}^3$, $k=0.14\text{W/m K}$, $c_p=1.78\text{kJ/kg }^\circ\text{C}$, $\nu=9\times 10^{-6}\text{m}^2/\text{s}$ | 10 | (3 :4: 1.7.1) |
| | c. Explain the physical significance of Nusselt number. | 04 | (2 :4: 1.6.1) |

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| 8. | a. Differentiate between laminar flow and turbulent flow | 05 | (1 :4: 1.6.1) |
| | b. Considering the body of man as vertical cylinder of 300 mm diameter and 160 cm height. If the temperature of the body is maintained at 36 °C, find the heat generated by the body in 24 hrs. Ambient temperature of air is 14 °C. | 10 | (3 :4: 1.7.1) |
| | c. Using Buckingham's π theorem, prove that $Nu=hL/k$ | 05 | (2 :4: 1.6.1) |

Module-5

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| 9. | a. Obtain an equation for Logarithmic Mean Temperature Difference (LMTD) for Parallel flow heat exchanger. | 10 | (2 :5: 1.6.1) |
| | b. Exhaust gases ($c_p=1.12 \text{ k J/kg K}$) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400 °C to 120 °C. This cooling is affected by water ($c_p = 4.18 \text{ k J/kg K}$) that enters the system at 10°C at the rate of 1500 kg/hr. If the overall heat transfer coefficient is $500 \text{ kJ/m}^2 \text{ hr } ^\circ\text{C}$, what heat exchanger areas is required to handle the load for parallel flow and counter flow arrangement? | 10 | (3 :5: 1.7.1) |

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| 10. | a. With neat sketch, explain the boiling regimes of water. | 10 | (3 :5: 1.6.1) |
| | b. Saturated steam at $t_{sat}=90 \text{ }^\circ\text{C}$ ($p=70.14\text{k Pa}$) the condenses on outer surface of a 1.5 m long, 2.5 m OD vertical tube maintained at a uniform temperature $t_a=70^\circ\text{C}$ (ambient). Assuming film wise condensation, calculate (i) Local heat transfer coefficient at the bottom of tube (ii) The average heat transfer coefficient over the entire length of the tube | 10 | (3 :5: 1.7.1) |

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