K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

WINTER-2025	
Exam Seat No.:	
Academic Year:2025-2026	Semester:V
Class:TY	Program:B.Tech
Branch Code:MEC	Pattern:2022
Name of Course:Heat Transfer	Course Code:MEC223002
Max. Marks:60	Duration:2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 3 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

		Marks	**CO**
Question No. 1			
1a)	What is composite wall and contact resistance? Explain with diagram of composite wall made up of three different materials also write heat transfer equation for the same	(6)	CO1
Question No. 2			
2a)	A cooper fin (k = 396 W/mK) 0.25cm in diameter protrudes from a wall at 95^{o}C into ambient air at 25^{o}C. The heat transfer coefficient by free convection is equal to 10 W/m^{2}k. Calculate the heat loss if (a) the fin is infinitely long (b) the fin is 2.5cm long with insulated tip.	(6)	CO2
Question No. 3			
3a)	Explain dimensionless numbers used in forced convection and natural convection	(8)	CO3
	OR		
3b)	Explain flow boiling phenomenon with diagram. Write true or false and justify: heat transfer in dropwise condensation is more than filmwise condensation.	(8)	CO3
3c)	Air, at mean bulk temperature of 20°C and 1 atm pressure, flows over a 0.5m-long and 1-m-wide flat plate parallel to its surface at a velocity of 5 m/s. The plate is at a uniform temperature of 80°C. Calculate heat transfer rate.	(8)	CO3
	OR		
3d)	Determine the hourly loss of heat from a bare horizontal steam pipe whose diameter is 100 mm and the length is 5 m. The pipe wall temperature is 450 K and the temperature of the surrounding air is 300 K. Assume that the radiation heat loss is negligible.	(8)	CO3
Question No. 4			
4a)	Explain the following terms i) Gray Body	(8)	CO3

ii) Emissivity

(iii) Radiation Intensity

(iv) Radiocity

OR

4b) Explain the laws of radiation: Stefan Boltzmann law, Plank's law, Kirchhoff's law, Wien's Displacement law. (8) CO3

4c) Two parallel infinite planes are facing each other. One of the planes has an emissivity of 0.8 and is maintained at 400 K while the other has emissivity of 0.7 and is at 500 K. Calculate the radiation heat exchange between the planes. If the planes are black, what will be the heat exchange? Also calculate the interchange factor/equivalent emissivity. (8) CO3

OR

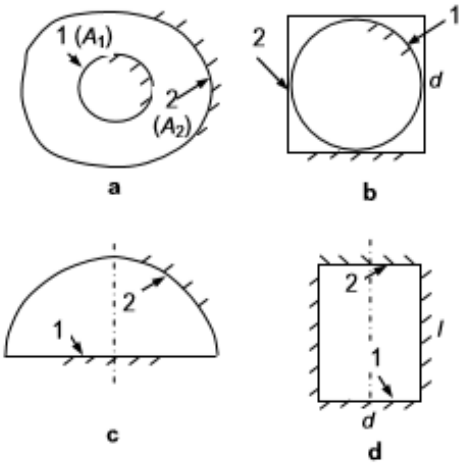
4d) Determine the shape factors for (8) CO3

(i) A blackbody inside a black enclosure (Fig. a)

(ii) A black sphere in a cubical box (Fig. b)

(iii) A black hemisphere surface closed by a plane surface (Fig. c)

(iv) A cylindrical cavity closed by a plane surface (Fig. d)



Question No. 5

5a) List the techniques used to enhance heat transfer in heat exchanger. Compare the LMTD Method and ε-NTU method used for analysis of heat exchanger. (8) CO4

OR

5b) Derive expression for Logarithmic Mean Temperature Difference (LMTD) for parallel flow heat exchanger (8) CO4

5c) Exhaust gases (C_p = 1.12 kJ/kg K are to be cooled from 700 K to 400 K. The cooling is to be affected by water C_p = 4.18 kJ/kg K available at 30°C. The flow rates for the exhaust gases and water are 1000 kg/hr and 1500 kg/hr, respectively. If the overall heat transfer coefficient is estimated to be 111 W/(m^2 K), calculate the heat transfer area required for (i) counterflow arrangement (ii) parallel flow arrangement in the exchanger. (8) CO4

OR

5d) A heat exchanger (surface area = 100 m^2) has overall heat transfer coefficient of 420 W/m^2 K. Find the outlet temperature of hot and cold fluids for both counter and parallel flow arrangements when the inlet temperatures of the hot and cold fluids are 700°C and 100°C, respectively. The mass flow rates and specific heat of the hot and cold fluids are 1000 kg/min and 3.6 kJ/kg K, and 1200 kg/min (8) CO4

and 4.2 kJ/kg K, respectively. Effectiveness for counter flow and parallel flow arrangement is 0.436 and 0.407 respectively.

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