PRN:		Course Code :	AER3603

Third Year B. **Tech** End Semester Examination Winter 2024

Heat Transfer

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Day and Date: Sat 23 Nov 2024 Max Marks: **100**

Time : 02:00PM To 05:00PM Duration: **03** hrs

Instructions:All questions are compulsory.

			Marks	Bloom's Level	CO
Q.1		**Attempt the following**			
	a)	Derive the heat conduction equation through hollow cylinder from general heat conduction equation. Assume steady state unidirectional heat flow in radial direction and no internal heat generation.	08	1	1
	b)	A closed system of constant volume experiences a temperature rise of 25°C when a certain process occurs. The heat transferred in the process is 30 KJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 KJ/kg°C and the system contains 2.5 kg of this substance. Determine (i) the change in internal energy and (ii) The work done.	08	2	1
		OR			
	b)	A jet aircraft compartment is assumed to be a cylindrical tube of 3 meter diameter and 20 meter length. It is lined inside with 3 cm of insulating material of k = 0.042 W/mK. It is flying at a height where the average outside temperature is -30°C. Determine the rate of heating required to maintain the compartment at 20°C for passenger comfort.	08	2	1
Q.2		**Attempt the following**			
	a)	Derive the three-dimensional heat conduction governing equation in Cartesian coordinates with neat sketch.	08	2	1
	b)	Two long rods of the same diameter, one of brass (k = 85 W/mK) and the other of copper (k = 375 W/mK) have one of their ends inserted in a furnace and the other ends exposed to the same atmosphere. At a distance of 105 mm away from the furnace the temperature of brass rod is 120°C. Determine the distance from the furnace end the copper rod would have attain the same temperature.	08	2	2
		OR			
	b)	One end of a long rod is inserted into a furnace while the other projects into ambient air. Under steady state the temperature of the	08	3	2

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rod is measured at two points 75 mm apart and found to be 125°C and 88.5°C respectively, while the ambient temperature is 20°C. If the rod is 25 mm in diameter and h is 23.36 W/m2K, Find the thermal conductivity of the rod material.

Q.3 Attempt any two from the following

a)	Distinguish between natural and forced convection heat transfer. Also define velocity and thermal boundary layer thickness.	08	1	2
b)	What is physical significance of dimensionless parameters? Explain any three numbers in brief.	08	2	3
c)	For natural convective heat transfer, prove that $Nu = \emptyset\ (Pr)(Gr)$, where Nu is Nusset Number, Pr is Prandtl Number and Gr is Grashoff number.	08	2	3

Q.4 Attempt any two from the following

a)	How are the heat exchangers classified? Sketch the temperature variations in (i) parallel flow heat exchanger (ii) counter flow heat exchangers (iii) Boiler (iv) Condenser	08	1	3
b)	What are fouling factors? Explain their effect in heat exchanger design.	08	2	4
c)	Derive an expression for log mean temperature difference of parallel and counter flow heat exchanger.	08	3	4

Q.5 Attempt any Two of the following

a)	Define the following terms: (i) Total emissivity, (ii) Grey body, (iii) Kirchhoff's law (vi) Lambert cosine law.	09	3	4
b)	Explain intensity of radiation and Derive expression for total emissive power.	09	2	4
c)	Derive the expression for radiant heat exchange between two black bodies separated by a non-absorbing medium.	09	3	5

Q.6 Attempt any Two of the following

a)	Define aerodynamic heating and its significance in high-speed flight.	09	2	5
b)	Describe the mechanisms of heat transfer involved in gas turbine engines.	09	2	5
c)	Discuss the role of thermal protection systems in managing aerodynamic heating effects on spacecraft during atmospheric re-entry.	09	3	5

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