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Model Question Paper 2022-23 (CBCS Scheme)
Sixth Semester B.E. Degree Examination (Mechanical Engineering)

HEAT TRANSFER

TIME: 03 Hours

Max. Marks: 100

- Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
 02. M: Marks, L: Blooms Level, C: Course outcomes
 03. Use of Heat Transfer Data Handbook, Thermodynamics Data Handbook and Steam Tables are permitted.
 04. Assume missing data suitably

Module-1			M	L	C
Q.01	a	Explain the boundary conditions of I st , II nd and III rd kind for the Cartesian coordinates.	10	L2	CO1
	b	A small electric heating application uses wire of 2 mm diameter with 0.8 mm thick insulation ($K=0.12\text{W/mK}$). The heat transfer coefficient on the insulated surface is $35\text{ W/m}^2\text{K}$. Determine the critical thickness in this case and the percentage change in the heat transfer rate if the critical thickness is used assuming the temperature difference between the surface of the wire and surrounding air remains unchanged.	10	L3	CO1
OR					
Q.02	a	Derive the general three-dimensional Heat Conduction Equation in Cartesian coordinates and state the assumptions made.	10	L2	CO1
	b	A 100mm diameter steam pipe is covered by layers of lagging. The inside layer is 40mm thick and has thermal conductivity of 0.07W/mK . The outside layer is 25mm thick and has $K_2=0.1\text{W/mK}$. The pipe conveys steam at a temperature of 130°C . The outside temperature of lagging is 24°C . If the steam pipe is 20m long, determine the heat lost per hour, interface temperature of lagging neglecting the resistance of steam pipe.	10	L3	CO1
Module-2					
Q.03	a	Derive the expression for the temperature distribution and heat transfer for a infinitely long fin of rectangular profile.	10	L3	CO3
	b	A 1 m long, 5 cm diameter cylinder placed in an atmosphere of 40°C is provided with 12 longitudinal straight fins ($k=75\text{ W/mK}$), 0.75 mm thick. The fin protrudes 2.5 cm from the cylinder surface. The heat transfer coefficient is $23.3\text{ W/m}^2\text{K}$. Calculate the rate of heat transfer if the surface temperature of the cylinder is 150°C .	10	L3	CO3

OR					
Q.04	a	Derive an expression of temperature distribution for lumped system.	10	L3	CO3
	b	A mild steel sphere of diameter 5 cm initially at a uniform temperature of 225°C has its surface suddenly exposed to an ambient temperature of 25°C with a heat transfer coefficient of 500 W/m ² K. Calculate a) The center temperature 2 min. after the start of cooling b) The temperature at the depth 1cm from the surface 2 min after the start of cooling. For mild steel, Take $K=60 \text{ W/mK}$, $\rho = 7850 \text{ Kg/m}^3$, $C_p= 460 \text{ J/KgK}$, $\alpha = 1.6 \times 10^{-5} \text{ m}^2/\text{sec}$	10	L3	CO3
Module-3					
Q.05	a	Explain how the numerical solution is obtained for an one dimensional transient heat transfer problem using finite difference method.	10	L2	CO1
	b	Differentiate between the experimental, analytical and numerical methods of determining the solution of a heat transfer problem.	10	L3	CO1
OR					
Q.06	a	State and Explain the following laws of radiation: Stefan Boltzmann Law Kirchoff's law Planck's law Wein's displacement law	10	L2	CO3
	b	Two large parallel plates with emissivities 0.5 and 0.8 are maintained at 800 K and 600 K respectively. A radiation shield having an emissivity of 0.1 on one side and 0.05 on the other side is placed in between. Calculate the heat transfer per unit area with and without the radiation shield.	12	L3	CO3
Module - 4					
Q.07	a	Differentiate between Free and Forced Convection. Also explain Velocity Boundary layer and Thermal Boundary layer.	10	L2	CO2
	b	A 200 W heater has a spherical casing of diameter 0.2 m. The heat transfer coefficient for conduction and convection from the casing to the ambient air is obtained from $Nu = 2 + 0.6Re^{1/2}Pr^{1/3}$, with $Re = 104$ and $Pr = 0.69$. The temperature of the ambient air is 30°C and the thermal conductivity of air is $k = 0.02 \text{ W/m.K}$. 1 Find the heat flux from the surface at steady state. 2 Find the steady state surface temperature of the casing.	10	L3	CO2
OR					
Q.08	a	Explain the experimental method of determining the heat transfer coefficient in Natural convection Vertical cylinder heated from inside.	10	L2	CO2
	b	Engine oil at 60°C flows over a 5 m long flat plate whose temperature is 20°C with a velocity of 2 m/s. Determine the total drag force and the rate of heat transfer per unit width of the entire plate.	10	L3	CO2

Module-5					
Q.09	a	Differentiate between the mechanism of filmwise and dropwise condensation. Explain why dropwise condensation is preferred over filmwise condensation.	10	L3	CO4
	b	A steam condenser consists of a square array of 400 tubes each 6mm in diameter. The tubes are exposed to saturated steam at a pressure of 0.15 bar. The tube surface is maintained at a temperature of 25°C. Calculate the condensation rate per unit length of the tube.	10	L3	CO4
OR					
Q.10	a	Derive an expression of LMTD for a Parallel flow heat exchanger.	10	L3	CO4
	b	A heat exchanger is required to cool 55,000 Kg/hr of alcohol from 66°C to 40°C using 40,000 Kg/hr of water entering at 5 ° C. Calculate 1. Exit temperature of water 2. Heat transfer rate 3. Surface area required for parallel flow heat exchanger. Take, $U = 580 \text{ W/m}^2\text{K}$, C_p for alcohol = 3760 J/KgK.	10	L3	CO4