Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

Course: Heat Transfer **Semester: IV**
Program: B.Tech Mechanical Engineering **Time : 03 hrs.**
Course Code: MECH2086 **Max. Marks: 100**

Instructions:
Heat Transfer Data book is allowed to use in the examination
Additional data is provided at the back of the question paper

SECTION A
(5Qx4M=20Marks)

S. No.		**Marks**	**CO**
Q 1	Explain the factors affecting thermal conductivity in solids, liquids, and gases. Why do metals have higher thermal conductivity than non-metals?	**4**	**CO1**
Q 2	A hot metal plate is exposed to air in a room and loses heat by conduction to the support, convection to the air, and radiation to the surroundings. Explain how all three modes of heat transfer occur simultaneously in this system.	**4**	**CO2**
Q 3	Discuss the role of thermal insulation in controlling heat losses. Describe critical radius of insulation for a cylinder and explain under what conditions adding insulation can actually increase heat loss.	**4**	**CO2**
Q 4	Explain the boundary layer development in forced convection over a flat plate. describe the relationship between Reynolds number and the heat transfer coefficient for laminar flow.	**4**	**CO1**
Q 5	Discuss the role of fins and heat sinks in electronic cooling. How do geometry and material selection impact the thermal performance of extended surfaces? What is meant by fin efficiency and how is it calculated?	**4**	**CO3**

SECTION B
(4Qx10M= 40 Marks)

Q 6	A 20 by 20 cm slab of copper 5 cm thick at a uniform temperature of 260°C suddenly has its surface temperature lowered to 35°C. Using the concepts of thermal resistance and capacitance and the lumped-capacity analysis, find the time at which the center temperature becomes 90°C; ρ=8900 kg/m^3, c_p =0.38 kJ/kg °C, and k =370 W/m°C.	**10**	**CO3**
Q7	A3.0-cm-thick plate has heat generated uniformly at the rate of 5×105 W/m^3. One side of the plate is maintained at 200°C and the other side at 45°C. Calculate the temperature at the center of the plate for k =16 W/m °C.	**10**	**CO2**

Q 8	Derive the expression for steady-state one-dimensional heat conduction through a composite wall made of three different layers with different thermal conductivities. Explain the concept of thermal resistance in series.	**10**	**CO3**
Q 9	Water at an average temperature of 300 K flows at 0.7 kg/s in a 2.5-cm-diameter tube 6 m long. The pressure drop is measured as 2 kPa. A constant heat flux is imposed, and the average wall temperature is 55°C. Estimate the exit temperature of the water. (OR) Air at 1 atm and 15◦C flows through a long rectangular duct 7.5 cm by 15 cm. A 1.8-m section of the duct is maintained at 120°C, and the average air temperature at exit from this section is 65°C. Calculate the airflow rate and the total heat transfer.	**10**	**CO4**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	(a). A circumferential fin of rectangular profile is installed on a 10-cm-diameter tube maintained at 120°C. The fin has a length of 15 cm and thickness of 2 mm. The fin is exposed to a convection environment at 23°C with *h* = 60 W/m^2 ◦C and the fin conductivity is 120 W/m°C. Calculate the heat lost by the fin expressed in watts.(10 Marks) (b). A composite wall is formed of a 2.5-cm copper plate, a 3.2-mm layer of asbestos, and a 5-cm layer of fiberglass. The wall is subjected to an overall temperature difference of 560°C. Calculate the heat flow per unit area through the composite structure. (OR) (a). Obtain an expression for the optimum thickness of a straight rectangular fin for a given profile area. Use the simplified insulated-tip solution. (b). A circumferential fin of rectangular profile surrounds a 2-cm-diameter tube. The length of the fin is 5 mm, and the thickness is 2.5 mm. The fin is constructed of mild steel. If air blows over the fin so that a heat-transfer coefficient of 25 W/m^2 °C is experienced and the temperatures of the base and air are 260 and 93°C, respectively, calculate the heat transfer from the fin.	**20**	**CO4**
Q 11	Water at the rate of 30,000 lb*m*/h [3.783 kg/s] is heated from 100 to 130 °F [37.78 to 54.44°C] in a shell-and-tube heat exchanger. On the shell side one pass is used with water as the heating fluid, 15,000 lb*m*/h [1.892 kg/s], entering the exchanger at 200°F [93.33◦C]. The overall heat-transfer coefficient is 250 Btu/h • ft2 • °F [1419 W/m^2 • °C], and the average water velocity in the 34-in [1.905-cm] diameter tubes is 1.2 ft/s [0.366 m/s]. Because of space limitations, the tube length must not be longer than 8 ft [2.438 m]. Calculate the number of tube passes, the number of tubes per pass, and the length of the tubes, consistent with this restriction.	**20 Marks**	**CO5**

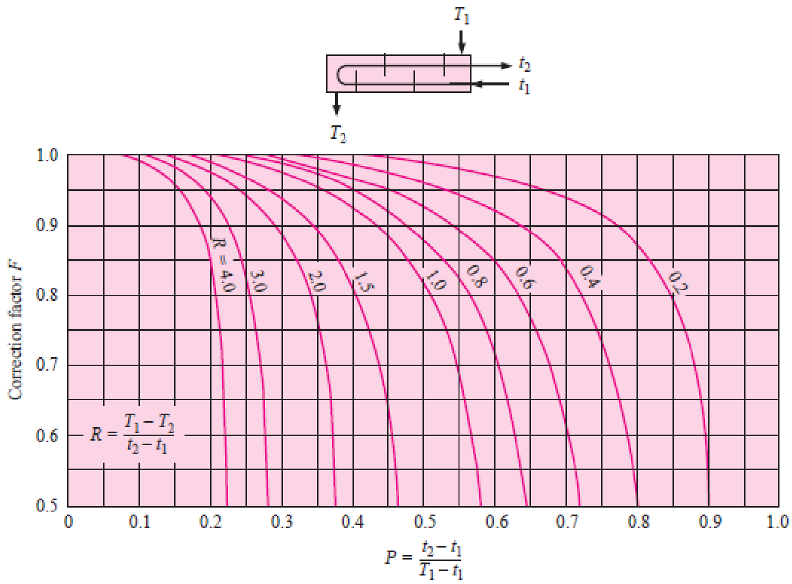
	Figure 10-8 | Correction-factor plot for exchanger with one shell pass and two, four, or any multiple of tube passes. 		

Figure 10-9 | Correction-factor plot for exchanger with two shell passes and four, eight, or any multiple of tube passes.

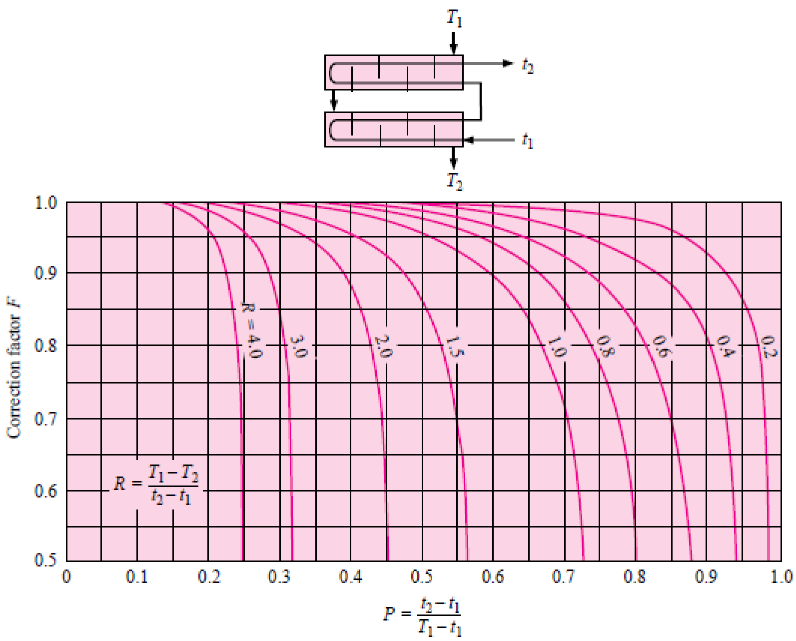


Figure 10-10 | Correction-factor plot for single-pass cross-flow exchanger, both fluids unmixed.