

USN

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

10ME63

Sixth Semester B.E. Degree Examination, July/August 2022
Heat and Mass Transfer

Time: 3 hrs.

Max. Marks:100

- Note:1. Answer any FIVE full questions, selecting atleast TWO questions from each part.**
2. Use of Data Handbook is permitted.

PART – A

1.
 - a. Derive three dimensional Heat Conduction equation in Cartesian Co-ordinates. (10 Marks)
 - b. A composite wall is made up of three layers of thickness 25cm, 12cm and 14cm of material A, B and C respectively. The thermal conductivities of A and B are 1.8 W/m K and 9.8 W/m K respectively. The outside surface is exposed to air at 20°C with convection coefficient of 15W/m² K and the inside is exposed to gases to 1200°C with convection coefficient of 48W/m² K. The inside surface temperature is 1115°C. Determine the unknown Thermal conductivity of layer made up of material C. (10 Marks)
2.
 - a. Define Fin efficiency and Fin effectiveness with respect to a Fin with insulated tip. (05 Marks)
 - b. What is Critical thickness of insulation for a small diameter wire or pipe? Explain its physical significance. (05 Marks)
 - c. A wire of 6mm diameter of a temperature of 62°C is to be insulated by a material having K = 0.175 W/m K. Convection heat transfer coefficient = 8.8W/m² K. The ambient temperature = 24°C. For maximum heat loss, what is the minimum thickness of insulation and heat loss per meter length? Also find percentage increase in heat dissipation. (10 Marks)
3.
 - a. Obtain an expression for instantaneous heat transfer and total heat transfer for lumped heat analysis treatment in heat conduction problems. (10 Marks)
 - b. A 12cm diameter long bar initially at a uniform temperature of 40°C is placed in a medium at 650°C with a convection coefficient of 22W/m² K. Calculate the time required for the bar to reach 255°C. Take K = 20W/m K, ρ = 580 kg/m³ and C_p = 1050 J/kg K. (10 Marks)
4.
 - a. With reference to fluid flow over a flat plate, discuss the concepts of velocity boundary layer and thermal boundary layer, with necessary sketches. (10 Marks)
 - b. A vertical plate 0.5m high and 1m wide is maintained at a uniform temperature of 124°C. It is exposed to ambient air at 30°C. Calculate the heat transfer rate from the plat. (10 Marks)

PART – B

5.
 - a. With the help of dimensional analysis, derive expression for the Reynolds number, Prandtl number and Nusselt number. (10 Marks)
 - b. Water at 50°C enters 1.5cm diameter and 3m long tube with a velocity of 1.5cm/s. The tube wall is maintained at 100°C. Calculate the heat transfer coefficient and total amount of heat transferred, if the water exit temperature is 70°C. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 6 a. Obtain the LMTD for a parallel flow heat exchanger. (10 Marks)
- b. Engine oil is to be cooled from 80°C to 50°C by using a single pass counter flow, concentric tube heat exchanger with cooling water available at 20°C . Water flows inside pipe of diameter 25mm at a rate of 0.08kg/s and oil flows through the annulus at a rate of 0.06 kg/s. The heat transfer coefficient for the water side and the oil side are $1000\text{W}/\text{m}^2\text{K}$ and $80\text{W}/\text{m}^2\text{K}$ respectively. Neglecting the tube wall resistance, calculate the length of the tube required. Take $C_{p\text{ water}} = 418\text{ J}/\text{kg K}$ and $C_{p\text{ oil}} = 2090\text{ J}/\text{kg K}$. (10 Marks)
- 7 a. Derive Nusselts theory of Laminar film condensation for condensation over a vertical flat plate. (10 Marks)
- b. Explain the different regimes of pool boiling with the help of neat sketches. (10 Marks)
- 8 a. Define the following :
- i) Black body.
 - ii) Kirchoif's law.
 - iii) Stefan – Boltzman law.
 - iv) Wien's displacement law.
 - v) Irradiation. (10 Marks)
- b. Two large parallel plates are at 1200K and 900K. Determine the heat exchange per unit area when
- i) The surface are black.
 - ii) The hot surface has an emissivity 0.8 and cold one 0.5.
 - iii) A shield of emissivity 0.03 is introduced between the plates having emissivities 0.8 and 0.5. Also find the percentage reduction in heat transfer due to the shield. (10 Marks)
