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Code No: 156BC

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, August - 2022

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 Hours **Max.Marks:75**

Answer any five questions
All questions carry equal marks

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1.a) Derive the general heat conduction equation in Cartesian Coordinate system.

b) A furnace wall consists of 200 mm layer of refractory bricks, 6 mm layer of steel plate and a 100 mm layer of insulation bricks. The maximum temperature of the wall is 1150^0C on the furnace side and the minimum temperature is 40^0C on the outermost of the wall. An accurate energy balance over the furnace shows that the heat loss from the wall is 400 W/m^2. It is known that there is a thin layer of air between the layers of refractory bricks and steel plate. Thermal conductivities for the three layers are 1.52, 45 and 0.138 W/m^{2}K respectively. Find
i) How many millimeters of insulation brick is the air layer equivalent?
ii) What is the temperature of the outer surface of the steel plate? [7+8]

2.a) Derive the expression for temperature distribution under one dimensional steady state heat conduction through composite cylinder.

b) Define thermal conductivity, thermal diffusivity and thermal resistance and write their equations. [7+8]

3.a) Derive an expression for temperature distribution and heat transfer rate through fin insulated at the tip.

b) What are the assumptions for lumped capacity analysis? Discuss. [8+7]

4. Aluminum fins of rectangular profile are attached on a plane wall with 5 mm spacing. The fins have thickness y = 1 mm, L = 10 mm, and the thermal conductivity K = 200 W/m K. The wall is maintained at a temperature 200^0C, and the fins dissipate heat by convection into the ambient air at 40^0C, with heat transfer coefficient h = 50 W/m^{2}K. Determine the heat loss. [15]

5.a) Explain the Reynold and Colburn Analogy.

b) A plate of length 750 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5 m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stoke, calculate
i) Boundary layer thickness at the middle of the plate.
ii) Shear stress at the middle of plate and
iii) Friction drag on one side of the plate. [7+8]

6.a) Show by dimensional analysis for free convection, Nusselts number is a function of Prandtl number and Grasshoff number.

b) What are the advantages and limitations of dimensional analysis? Explain. [8+7]

7.a) Derive expression for effectiveness by NTU method for parallel flow heat exchanger.

b) Steam at atmospheric pressure enters the shell of a surface condenser in which the water flows through a bundle of tubes of diameter 25 mm at the rate of 0.05 Kg/s. The inlet and outlet temperatures of water are 15^0C and 70^0C respectively. The condensation of steam takes place on the outside surface of the tube. If the overall heat transfer coefficient is 230 W/m^{2}K, calculate the following using NTU method:

i) The effectiveness of the heat exchanger

ii) The length of the tube

iii) The rate of steam condensation

Take the latent heat of vaporization at 100^0C is 2257 kJ/kg. [7+8]

8.a) Explain briefly the various regimes of saturated pool boiling by drawing the diagram.

b) What is a black body? How does it differ from a gray body? Discuss in detail. [8+7]

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