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P.E.S. College of Engineering, Mandy - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Automobile Engineering

Semester End Examination; May/June - 2019

Heat Transfer

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. State the laws governing three basic modes of heat transfer. 6

b. What is the thickness required of a monsory wall having thermal conductivity of 0.75 W/m-K, is the heat transfer rate is to be 80% of the rate through another wall having thermal conductivity of 0.25 W/m-K and a thickness of 100 mm? Both walls are subjected to some temperature difference. 6

c. Write the 3D heat conduction equation in Cartesian and Spherical coordinates and explain the terms involved. 8

2 a. What do you mean by boundary condition of 1^{st}, 2^{nd} and 3^{rd} kind? 6

b. Consider a solid cylinder of radius R and height Z. The outer curved surface the cylinder is subjected to a uniform heating electrically at a rate of q_0 W/m^2. Both the circular surfaces of the cylinder are exposed to on environment at a uniform temperature T_∞ with a surface heat transfer coefficient *h*. Write the mathematical formulation of the boundary conditions for the solid cylinder. 8

c. Consider a rectangular plate as in Fig. Q 2(c). The plate is generating heat at a uniform rate of q^{111} W/m^3. Write the mathematical formulation to determine one dimensional steady state temperature distribution in the plate. 6

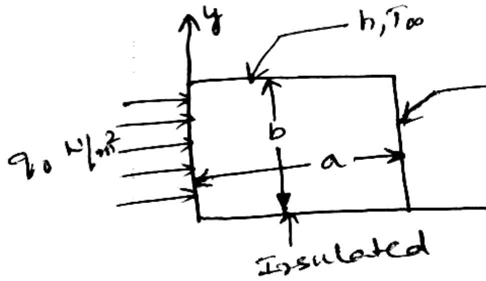

Fig Q 2(c)

UNIT - II

3 a. Derive an expression for critical thickness of insulation for a cylinder. Explain its physical significance. 10

b. A plane composite wall consists of three different layers in perfect contact. The first layer is 5 cm thick with K = 20 W/m-K. The second layer is 10 cm thick with K = 100 W/m-K. The outer surface of the first layer is in contact with a fluid at 400°C with a surface heat transfer coefficient of 25 W/m^2-K, while the outer surface of third layer is exposed to an ambient at 30°C with a surface heat transfer coefficient of 15 W/m^2-K. Draw the equivalent thermal circuit indicating the numerical values of all the thermal resistance and calculate the heat flow through composite wall and over all heat transfer coefficient. 10

4 a. Derive an expression for temperature distribution for rectangular fin with tip-insulated. 10

b. A steel rod of 12 mm × 12 mm with a length of 159 mm protrudes into air at 35°C from furnace wall at 200°C. The thermal conductivity of the material is 51.9 W/m-K and connective heat transfer coefficient is 22 W/m^2K. Determine; i) The end temperature, assuming the end insulated ii) The temperature at 80 mm distance from the wall 10

UNIT - III

5 a. Derive an expression for instantaneous heat transfer and total heat transfer for lumped heat analysis. 10

b. Aluminium rod of 5 cm diameter and 1 meter long at 200°C is suddenly exposed to a temprature (convective atmosphere) of 70°C. Calculate the temperature at a radius of 1 cm and heat loss per metre length of the rod, one minute after the cylinder is exposed to the environment . 10

6 a. With the help of dimensional analysis, derive an expression which relates Reynold's number, Nusselt number and Prandtl number. 10

b. Air stream at 30°C is moving at 0.5 m/s across at 100 W electric bulb at 130°C. If the bulb is approximated by a 60 mm diameter sphere, estimate the rate of heat transfer. 10

UNIT - IV

7 a. Explain the physical significance of :
i) Grashoff number ii) Prandtl number iii) Nusselt number iv) Reynold's number 8

b. A 5 cm diameter pipe carrying hot water is exposed to the ambient air at 15°C. If the outer surface of the pipe is at 65°C. Find the rate of heat loss from 1 m pipe length, when?
i) The pipe is horizontal ii) The pipe is vertical 12

8 a. Derive an expression for LMTD for counter flow heat exchanger. 10

b. Two shell pass 4 tube counter flow heat exchanger has water on the shall side and brine on the tube side water is cooled from 18°C to 6°C, with brine entering at –1°C and leaving at 3°C. The overall heat transfer coefficient is 600 W/m^2K. Calculate the heat transfer area required for a designed heat load of 24000 W. 10

UNIT - V

9 a. Explain the following :
i) Blackbody ii) Kirchhoff''s law iii) Stefan Boltzmann law
iv) Wein's displacement law v) Planck's law 10

b. Two parallel plates at T_1 = 900°K and T_2 = 500°K have emmisivities $\epsilon_1 = 0.6$ and $\epsilon_2 = 0.9$ respectively . A radiation shield having on emisivity $\epsilon_{31} = 0.15$ on one and emmisivtiy $\epsilon_{32} = 0.66$ on the otherside is placed between the plates. Calculate the heat transfer rate by radiation per source meter with and without shield. 10

10 a. For a black body enclosed in a hemispherical space, show that emissive power of the black body is π times the intensity of radiation. 8

b. Two large parallel plates are at 1000°K and 800°K. Determine the heat exchange per unit area, when?
i) The surface are black
ii) The hot surface has on emissivity of 0.9 and cold 0.6
iii) A large plate of emisivity 0.1 is inserted between them. Also find the percentage reduction in heat transfer because of introduction of large plate 12

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