Code No: RT32035 **R13** SET - 1

III B. Tech II Semester Supplementary Examinations, November/December - 2016
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Heat transfer data book allowed)

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PART –A

1 a) Calculate the rate of heat transfer per unit area through a copper plate 45 mm thick, whose one face is maintained at 350° C and the other face at 50° C. Take thermal conductivity of copper as 370 W/m$^{\circ}$C. [3M]

b) Calculate the amount of energy required to solder together two very long pieces of bare copper wire 1.5 mm diameter with solder that melts at 190°C. The wires are positioned vertically in air at 20° C. Assume that the heat transfer coefficient on the wire surface is 20 W/m$^{\circ}$ C and thermal conductivity of wire alloy is 330 W/m$^{\circ}$ C [4M]

c) Discuss the physical significance of Stanton number and Grashoff number [4M]

d) Write the momentum equation for hydrodynamic boundary layer over a flat plate. Explain the physical meaning of each term contained in it. [4M]

e) Describe about film wise condensation. [3M]

f) Define the terms absorptivity, reflectivity and transmittivity of radiation. [4M]

PART -B

2 a) A standard cast iron pipe (inner diameter = 50 mm and outer diameter = 55 mm) is insulated with 85 percent magnesium insulation (k = 0.02 W/m$^{\circ}$C). Temperature at the interface between the pipe and insulation is 300° C. The allowable heat loss through the pipe is 600 W/m length of pipe and for the safety, the temperature of the outside surface of insulation must not exceed 100° C. Determine i) Minimum thickness of insulation and ii) the temperature inside surface of the pipe assuming its thermal conductivity as 20 W/m$^{\circ}$ C. [10M]

b) Derive the expression for temperature distribution associated with radial conduction through a sphere. [6M]

3 a) A turbine blade made of stainless steel (k = 29 W/m^{0} C) is 60 mm long, 500 mm^{2} cross-sectional area and 120 mm perimeter. The temperature of the root of blade is 480° C and is exposed to products of combustion passing through the turbine at 820° C. If the film coefficient between the blade and the combustion gases is 320 W/m^{2o}C, determine i) the temperature at the middle of the blade; ii) the rate of heat flow from the blade. [12M]

b) Explain the significance of Heisler charts in solving transient conduction problems. [4M]

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4 Using Buckingham π dimensional analysis, derive an expression for heat transfer coefficient for a free convection. The variables involved are h(heat transfer coefficient), ρ(fluid density), D(tube diameter), μ(fluid viscosity), c_p(specific heat), k (thermal conductivity), βg t (β - coefficient of volume expansion of the fluid, t - difference of temperatures between the heated surface and the undisturbed fluid). [16M]

5 A vertical cylinder 1.5 m high and 180 mm in diameter is maintained at 100^0 C in an atmospheric environment of 20^υ C. Calculate heat loss by free convection from the surface of the cylinder. Assume properties of at mean temperature as ρ = 1.06 kg/m^3, υ = 18.97x10^{-6} m^2/s, c_p = 1.004 kJ/kg^{0}C and k = 0.1042 kJ/mh^{0}C. [16M]

6 a) Derive an expression for logarithmic mean temperature difference (LMTD) in case of counter flow heat exchanger. [10M]

b) A vertical plate 2.8 m high is maintained at 54^υ C in the presence of saturated steam at atmospheric pressure. Calculate the heat transfer per unit width. [6M]

7 Two parallel black plates 0.5 x 1.0m is spaced 0.5m apart. One plate is maintained at 1000^0c and the other at 500^0c .What is the net radiant heat exchange between the two plates? [16M]

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