Code No: R1631245 **R16** SET - 1

III B. Tech I Semester Supplementary Examinations, May - 2019

HEAT TRANSFER

(Automobile Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**
4. Heat Transfer Data Book allowed

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PART –A

1. a) What is Fourier's Law of Conduction? Explain. [2M]
   b) Explain any three varieties of fins available for heat transfer. [2M]
   c) Write any three dimensionless numbers which play an important role in heat transfer. [2M]
   d) Define Energy thickness and Momentum thickness. [3M]
   e) Discuss the applications of boiling heat transfer. [3M]
   f) What is burnout point? [2M]

PART -B

2. a) A metal piece of length l has a cross-section of a sector of a circle of radius r and included angle of θ. Its two ends are maintained at temperature t_1 and t_2($t_1 > t_1$). Find the expression for heat flow through the metal piece, assuming that the conductivity of metal varies with temperature according to relation. [7M]
   $k = k_0(1-\beta t)$
   Also assume that

$$\frac{\partial t}{\partial \theta} = 0 \text{ and } \frac{\partial t}{\partial r} = 0$$

   and outer surfaces of the slab except the end surfaces are completely insulated. What will be the rate of heat transfer if l = 600 mm, r = 120 mm, θ = 60^o, $t_1 = 125^oC$, $t_2 = 25^oC$ and $k_o = 115$ W/m^oC and $\beta = 10^{-4}$?
   b) Derive an equation to calculate the critical thickness of insulation for a cylinder. [7M]

3. a) Derive an expression for heat transfer through an infinitely long rectangular fin. [7M]
   b) A 50cm *50 cm copper slab 6.25mm thick has a uniform temperature of 300^oC. Its temperature is suddenly lowered to 36^oC. Calculate the time required for the plate to reach the temperature of 108^oC. [7M]
   Take ρ = 9000 kg/m^3, c = 0.38 kJ/kg^oC ; k = 370 W/m^oC and h = 90 W/$m^{2o}C$

4. a) Write in brief about the following [7M]
   i) Geometric similarity ii) Kinematic similarity iii) Dynamic similarity
   b) The pressure difference ΔP in a pipe of diameter D and length l due to turbulent flow depends on the velocity V, viscosity μ, density ρ and roughness k. Using Buckingham's Π-theorem, obtain an expression for ΔP. [7M]
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5. a) Air at atmospheric pressure and 200^{o}C flows over a plate with a velocity of 5 m/s. The plate is 15 mm wide and is maintained at a temperature of 120^{o}C. Calculate the thicknesses of hydrodynamic and thermal boundary layers and the local heat transfer coefficient at a distance of 0.5 m from the leading edge. Assume that the flow is on one side of the plate. [7M]
ρ = 0.815 kg.m^{3} ; μ= 24.5*10-6 Ns/m^{2}; Pr = 0.7, k = 0.0364 W/m K

b) A square plate 40 cm * 40 cm maintained at 400 K is suspended vertically in atmospheric air at 300 K. [7M]
i) Determine the boundary layer thickness at trailing edge of the plate
ii) Calculate the average heat transfer coefficient using a relation
$Nu=0.516(Gr_L . Pr)^{0.25}$
Take the following properties of air
$\nu = 20.75*10^{-6}$ m^{2}/s ; k = 0.03 W/m^{o}C ; $\beta= 2.86 * 10^{-3}$ K^{-1}; Pr = 0.7

6. a) In a shell and tube counter-flow heat exchanger water flows through a copper tube 20 mm I.D (internal diameter) and 23 mm O.D(outer diameter), while oil flows through the shell. Water enters at 20^{o}C and comes out at 30^{o}C, while oil enters 75^{o}C and comes out at 60^{o}C. The water and oil side film coefficients are 4500 and 1250 W/m^{2o}C respectively. The thermal conductivity of the tube wall is 355 W/m^{o}C. The fouling factors on the water and oil sides may be taken to be 0.0004 and 0.001 respectively. [7M]
If the length of the tube is 2.4 m, calculate the following :
i) Overall heat transfer coefficient ii) The heat transfer rate

b) Explain briefly the various regimes of saturated pool boiling. [7M]

7. a) Consider two large parallel plates; one at 1000 K with emissivity 0.8 and other is at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield. [7M]

b) Explain the following [7M]
i) Kirchhoff's Law ii) Planck's Law

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