Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

Course Code: ME302

Course Name: Heat and Mass Transfer

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) What are the mechanisms of heat transfer? How are they distinguished from each other? (5)

b) A hollow sphere (k = 65 W/mK) of 120 mm inner diameter and 350 mm outer diameter is covered 10 mm layer of insulation (k =10 W/mK). The inside and outside temperatures are 500°C and 50°C respectively. Calculate the rate of heat flow through this sphere. (5)

2 a) Derive the general heat conduction equation in Cartesian coordinates (10)

3 a) Explain velocity boundary layer and thermal boundary layer with neat sketches. (5)

b) Discuss the significance Nusselt number and Prandtl number in convection (5)

4 Air at 20°C at atmospheric pressure flows over a flat plate at a velocity of 3 m/s. If the plate is 1 m wide and at 80°C, calculate the following at x = 300 mm. (10)

i. Hydrodynamic boundary layer thickness

ii. Thermal boundary layer thickness

iii. Local friction coefficient

iv. Average heat transfer coefficient

v. Heat transfer rate

PART B

Answer any three full questions, each carries 10 marks.

5 An aluminium alloy fin (k = 200 W/mK) of 1 m width, 3.5 mm thick, and 2.5 cm long protrudes from a wall. The base is at 420°C, the ambient air temperature is 30°C and the heat transfer coefficient is 11 $W/m^2.K$. Find the rate of heat loss and fin efficiency, if the fin tip is insulated. (10)

6 Derive equations of temperature distribution and heat dissipation for an infinitely long fin (10)

7 Derive an expression for Log Mean Temperature Difference in the case of a counter flow heat exchanger. (10)

8 In a double pipe heat exchanger hot water flows at a rate of 14 kg/s and gets (10)

cooled from 370K to 340K. At the same time 14 kg/s of cooling water at 303K enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2 K. Determine the effectiveness and the heat transfer area required, assuming two streams are in parallel flow. Assume the specific heat for the both the streams = 4.2 kJ/kg K.

PART C

Answer any four full questions, each carries 10 marks.

9 a) Define Irradiation and Radiosity for a grey body. (3)

b) State and Explain Wein's displacement law (3)

c) Distinguish between a black body and gray body (4)

10 Derive the following relation for the radiant heat exchange between two gray surfaces (10)

$$(Q_{12})_{net} = \frac{A_1\sigma(T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1} + \frac{1}{\bar{F}_{1-2}} + \left(\frac{1-\varepsilon_2}{\varepsilon_2}\right)\frac{A_1}{A_2}}$$

11 Calculate the heat exchange by radiation between the surfaces of two long cylinders having radii 120 mm and 60 mm respectively. The axes of the cylinders are parallel to each other. The inner cylinder is maintained at a temperature of 130°C and emissivity of 0.6. Outer cylinder is maintained at a temperature of 30°C and emissivity of 0.5. (10)

12 a) State and explain the governing law for Diffusion mass transfer? (4)

b) Discuss the analogy between heat transfer and mass transfer (6)

13 a) What are the different modes of mass transfer, give examples for each (6)

b) Explain the phenomenon of equimolar counter diffusion with an example (4)

14 a) Define and explain the physical significance of (4)

i) Schmidt number

ii) Sherwood number

b) Dry air at 30^{0}C and 1 atm flows over a wet flat plate 600 mm long at a velocity of 50 m/s. Calculate the mass transfer co-efficient of water vapour in air at the end of the plate. Take the diffusion co-efficient of water vapour in air, (6)

D = 0.26 x 10^{-4} m^2/s

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