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Code No: 126EF

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech III Year II Semester Examinations, May - 2016
HEAT TRANSFER
(Common to ME, AME, MSNT)

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

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1.a) Define thermal diffusivity. [2]
b) What is the difference between homogeneous and isotropic material. [3]
c) Discuss about semi infinite body. [2]
d) What are Biot and Fourier numbers? Explain their physical significance. [3]
e) State the scope and application of dimensional analysis in heat transfer process. [2]
f) Draw boundary layer growth in a pipe for laminar and turbulent flows in a pipe and indicate salient features. [3]
g) Define irradiation and radiosity. [2]
h) What are the differences between drop wise and film wise condensation? [3]
i) What is the difference between regenerator and recuperator? [2]
j) What is LMTD correction factor? [3]

PART - B

(50 Marks)

2.a) Derive general heat conduction equation in Cartesian Co-ordinates.
b) What is meant by conduction shape factor? Explain its significance along with periodic and aperiodic heat transfer. [5+5]

OR

3. What is the use of initial and boundary conditions? Discuss the conditions:
a) Prescribed surface temperature
b) Prescribed heat flux
c) Convective condition in detail. [3+3+4]

4.a) Define the overall heat transfer coefficient? Obtain the expression for composite wall with three layers with convective conditions over the wall.
b) Distinguish between steady state conduction and unsteady state conduction. [6+4]

OR

5.a) Develop an expression for temperature distribution in a slab made of single material.
b) Sheets of brass and steel, each of thickness 1cm, are placed in contact. The outer surface of brass is kept at 100^0C and the outer surface of steel is kept at 0^0C. What is the temperature of the common interface? The thermal conductivities of brass and steel are in the ratio of 2:1. [5+5]

6.a) Differentiate between mechanisms of heat transfer by free and forced convection. Mention some of the areas where these mechanisms are predominant.

b) A nuclear reactor with its core constructed of parallel vertical plates 2.25 m high and 1.5 wide has been designed on free convection heating of liquid bismuth. Metallurgical considerations limit the maximum surface temperature of the plate to 975^0 C and the lowest allowable temperature of bismuth is 325^0 C. Estimate the maximum possible heat dissipation from both sides of each plate. The appropriate correlation for the convection coefficient is $Nu = 0.13(Gr\ \mathrm{Pr})^{1/3}$ where the different parameters are evaluated at the mean film temperature. [5+5]

OR

7.a) How are the local and average convection coefficients for flow past a flat plate are related? Derive the relationship.

b) Water at 75^0C flows through a 0.005 m diameter tube with a velocity of 1m/s. If the tube wall temperature is 25^0C, make calculations for the heat transfer coefficient. Use the correlation, $St = 0.023\ Re^{0.2}\ Pr^{-0.667}$.
The thermo-physical properties of water are:
Thermal conductivity is 0.647 W/(m.K); Viscosity is 1.977 kg/h.m;
Density is 1000 kg/m^3; Specific heat 4.187 kJ/(kg.K). [5+5]

8.a) What is Stefan-Boltzmann Law? Explain the concept of total emissive power of a surface.

b) Saturated steam at 2 bar condenses on a cylindrical vertical drum having an outside diameter of 25 cm and a temperature of 90^0 C. Calculate how long must the drum be to condense 50 kg of steam per hour. Also estimate the thickness of condensate layer. [5+5]

OR

9.a) Derive general relation for the radiation shape factor in case of radiation between two surfaces.

b) A copper pan of 35 cm diameter contains water and its bottom surface is maintained at 115^0 C by an electric heater. Calculate the power required to boil water in this pan and the rate at which water evaporates from the pan due to the boiling process. Also make calculations for the heat flux for these conditions. [5+5]

10. It is required to design a shell and tube heat exchanger for heating 9000 kg/hr of water from 15^0C to 88^0C by hot engine oil (Cp = 2.35 kJ/kg-K) flowing through the shell of the heat exchanger . The oil makes a single pass, entering at 150^0C and leaving at 95^0C with an average heat transfer coefficient of 400 W/m^2-K, the water flow through 10 thin walled tubes of 25mm diameter with each tube making 8 passes through the shell. The heat transfer efficient on the water side is 3000 W/m^2-K. Find the length of the tube required for the heat exchanger. [10]

OR

11.a) Derive an expression for LMTD in case of a counter – current flow double pipe heat exchanger.

b) A hot fluid enters a heat exchanger at a temperature of 200^0C at a flow rate of 2.8 kg/sec (sp. heat 2.0 kJ/kg-K) it is cooled by another fluid with a mass flow rate of 0.7 kg/sec (Sp. heat 0.4 kJ/kg-K). The overall heat transfer coefficient based on outside area of 20 m^2 is 250 W/m^2-K.Calculate the exit temperature of hot fluid when fluids are in parallel flow. [5+5]

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