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18E31

B. Tech. EXAMINATION, 2020

(Fifth Semester)

(C Scheme) (Main Only)

(ME)

ME301C

HEAT TRANSFER

Time : 2½ *Hours*] [*Maximum Marks :* 75

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Four* questions in all. All questions carry equal marks. Assume suitable value for missing quantity or parameters, if any.

1. (a) What do you understand by phonons in heat transfer ? Define thermal diffusivity.

(b) An insulated pipe of 50 mm outside diameter ($\in$ = 0.8) is laid in room at 30ºC. if the surface temperature is 250ºC and convective heat transfer coefficient is 10 W/m^2 K, calculate the heat loss per unit length of pipe.

2. (a) Write differential conduction equation for cylindrical and spherical systems with the help of neat diagram.

(b) A hollow cylinder with 50 mm internal diameter and 100 mm outer diameter has an inner surface temperature of 200ºC and outer surface temperature of 100ºC. Determine the temperature of the point halfway between the inner and outer surfaces. If the thermal conductivity of the cylinder material is 70 W/mK, determine the heat flow through the cylinder per linear meter.

3. (a) Derive expression for fin efficiency and fin effectiveness.

(b) Obtain the temperature distribution and rate of heat transfer at the root of a turbine blade with 8 cm long, cross-sectional area of 600 mm^2 and perimeter 15 cm. Tip of blade is insulated and blade is made stainless steel. The blade is exposed to steam at 1000ºC and root temperature is 600ºC. The heat transfer coefficient between the blade surface and gas is 500 W/m^2K. Given $k_{\text{stainless steel}}$ = 23.3 W/mK.

4. (a) What do you mean by Fourier number and Biot number ? Draw a chart to distinguish all regimes of transient problem in terms of Fourier number and Biot number.

(b) A mercury thermometer bulb, idealized as a sphere of 1 m radius is used for measuring the temperature of a fluid whose temperature is varying very fast rate. For mercury k = 10 W/mK, $\alpha = 5 \times 10^{-5}$ and h = 10 W/m^2K. Specify whether the thermometer is able to read the temperature accurately, if the time for temperature change is 3s. If not what should be the diameter of a thermocouple (k = 100 W/mK, $\alpha = 120 \times 10^{-5}$, h = 8 W/m^2K) to read the temperature of fluid.

5. (a) Define hydrodynamic and thermal developing flow in circular pipe.

(b) If the velocity distribution in the boundary layer of a flat plate is given by an expression $u/\mathrm{U} = \sin\left((\pi/2)(\delta/d)\right)$, prove the final expression would be $\delta/x = 48/\sqrt{\mathrm{Re}_x}$. Where δ represents to boundary layer thickness.

6. (a) Define Kirchhoff's law, Stefan Boltzmann's law and Wien's displacement law.

(b) Two parallel circular discs of radius 50 cm are spaced 50 cm apart. One plate is maintained at 1100 K and second plate is at 1900 K. The plates are located in a large room, which is maintained at 300 K. The circular discs exchange heat with each other and also with room, but the circular discs facing each other are to be considered. The emissivities of disc one and two are 0.2 and 0.5 respectively. Calculate the net heat exchange to each disc and to the room. **9**

7. (a) What is heat exchanges ? Classify the basic heat exchangers based on transfer process, degree of surface compactness, construction features and heat transfer mechanism.

(b) A counter flow concentric tube heat exchanger is used to cool engine oil (cp = 2.130 kJ/kg.K) from 160ºC to 60ºC with water, available at 25ºC as the cooling medium. The flow rate of cooling water through the inner tube of 50 cm diameter is 2 kg/s while the flow rate of oil through the outer annulus outer diameter of 70 cm is also 2 kg/s. If the value of overall heat transfer coefficient is 250 Wm^2K, how long must the heat exchanger be meet its cooling requirement ?

8. (a) What do you understand by two phase heat transfer ?

(b) Explain the pool boiling and flow boiling and drop wise condensation.