QPC: RO20MTECH245 AR 19 Reg. No | | | | | | | | | | |

GIET UNIVERSITY, GUNUPUR – 765022

M. Tech (Second Semester – Regular) Examinations, October – 2021

MPCTE2010 – CONVECTIVE HEAT TRANSFER

(Heat Power and Thermal Engineering)

Time: 2 hrs Maximum: 50 Marks

The figures in the right hand margin indicate marks.

PART – A **(2 x 10 = 20 Marks)**

Q1. Answer **ALL** questions

a. How is natural convection different from forced convection?

b. Which mode heat transfer is the convection heat transfer coefficient usually higher, natural or forced convection? Why?

c. Do you expect the convective heat transfer coefficient in the thermally developing region to be higher or lower than the convective heat transfer coefficient in the fully developed temperature profile region?

d. Explain why the temperature boundary layer grows much more rapidly than the velocity boundary layer in liquid metals.

e. Define boundary layer thickness.

f. Define Reynolds number (Re) and prandtl number (Pr).

g. Differentiate Nusselt number and Biot number

h. What do you understand by the terms fully developed velocity and temperature profile regions in internal flow ?

i. What is meant by laminar flow and turbulent flow?

j. What are the dimensionless parameters used in forced convection

PART – B **(6 x 5 = 30 Marks)**

<u>Answer ***ANY FIVE*** questions</u> **Marks**

2. The velocity profile for laminar boundary layer is on the form given below. $\frac{u}{U} = 2[\frac{y}{\delta}] - [\frac{y}{\delta}]^2$. Find the thickness layer of boundary layer at the end of the plate 1.5 m long and 1 m wide when placed in water flowing with a velocity of 0.12 m/s. Calculate the volume of coefficient of drag also. Take μ for water as 0.001 N-s/m^2 **(6)**

3. Derive an energy equation for thermal boundary layer over a flat plate. **(6)**

4. Derive an expression for turbulent boundary layer thickness, Shear stress, Local skin friction coefficient and average value of skin friction coefficient over a flat plate. **(6)**

5. Lubricating oil at a temperature of 60^0 C 1 cm diameter tube with a velocity of 3 m/s. The tube surface is maintained at 40^0 C. Assuming that the oil has the following average properties. Calculate the tube length required to cool the oil to 45^0 C. **(6)**

   P = 865 kg/m^3, k = 0.14 W/m K, C_p = 1.78 KJ/kg K.

   Assume flow to be laminar (Average Nu = 3.657)

6. Caster oil at 25^0 C flows at a velocity of 0.1 m/s past a flat plate. In a certain process. If the plate is 4.5 m long and is maintained at a temperature of 95^0 C, Calculate the following. **(6)**

   (i) The hydrodynamic and thermal boundary layer thickness on one side of the plate.
   (ii) The total drag force per unit width on one side of the plate.
   (iii) The local heat transfer coefficient at the trailing edge

(iv) The heat transfer rate.

Take properties of oil at mean film temperature as $\rho = 956.8$ kg/m^3, $\alpha = 7.2 \times 10^{-8}$ m^2/s, k = 0.213 W/ m K and $\nu = 0.65 \times 10^{-4}$ m^2/s.

7. In a straight tube of 60 mm diameter water is flowing at a velocity of 12 m/s. The tube surface temperature is maintained at 70^0 C and flowing water is heated from the inlet temperature 15^0 C to an outlet temperature of 45^0 C. Taking the physical properties of water at its mean bulk temperature, calculate the following: **(6)**

   (i) The heat transfer coefficient from the tube surface to the water
   (ii) The heat transferred
   (iii) The length of the tube

8. A fluid is flowing in a pipe which is 300 mm in diameter, 3.5 m long and whose surface in maintained at a constant temperature. The temperature of the wall surface at the inlet section of the pipe exceeds the fluid temperature by 40^0 C. What is the rise in the fluid temperature of the end section of the pipe? **(6)**

   The Reynolds analogy holds good which is given by $S_t = f/8$ where friction factor f = 0.022.

--- End of Paper ---