M. MECH ENGG. EXAMINATION 2017
FIRST YEAR, 2ND SEMESTER
Subj: CONVECTION HEAT TRANSFER

Time: Three hours **Full Marks: 100**

Answer **question No. 1 (Compulsory)** and **any four questions** from the rest

NB: Assume any data, if not furnished, consistent with the problem. Use of relevant tables and charts are permitted.

1. a) Explain what do you mean by simultaneously developing boundary layer. In this connection discuss the relationship between the height of thermal and hydrodynamic boundary layer

b) Show that Nusselt number is non-dimensional temperature gradient for heat transfer from one-dimensional plate at constant temperature.

c) A duct with 1 cm diameter under laminar flow regime is pumped with water. The duct wall is maintained at a temperature of 30° C. If the thermal conductivity of water is w/Mk find out the heat transfer coefficient.

d) Isentropic turbulence implies homogeneous turbulence' – comment on this statement and explain if the homogenous turbulent field leads to isentropic turbulence.

9+3+4+4

2. a) Write down the Reynolds stress term for a 3-D flow and hence explain the concept of turbulent viscosity

b) Explain turbulent Prandtl number in brief.

c) Discuss the factors affecting critical Reynolds number.

d) Temperature and velocity values at 10 intervals were found to be (10.9, 10.7,10.6,10.2,10.1,10,9.8,9.6,9.5,9.4,9.2) and (0.1,0.2,0,3,0.4,0.5,0.6,0.7,.0.8. 0.9, 1.0,1.1) Find out the value of $\overline{T'^2}$ and u_{rms}

7+3+4+6

3. a) Derive the non-dimensional governing equations for natural convection over a vertical flat plate.

b) In a thermal system both forced and natural convection is present. Discuss the criteria for neglecting one aspect over the other and how the combined convection is calculated when both type of convections are significant

14+6

4. a) Discuss the boiling curve and label different important points and regimes. In this connection, explain critical heat flux and its significance

   b) State the important non-dimensional numbers for boiling along with the expressions.

(10+3)+7

5. a) A hot wall of 0.25 m width and 0.5 m high at 200^0 C is exposed to environment at 20^0 C. Find out the heat flux from the surface using the relationship

$$Nu= 0.68+0.67Ra^{1/4}/(1+(0.49/Pr)^{9/16})^{4/9}$$

The relevant properties $\upsilon=24.10 \times 10^{-6}$ m^2/s, k = 0.03194 W/mK and Pr = 0.74

   b) Water flows through a tube with diameter of 25 mm. At a location of 3m from inlet, water velocity is 3 m/s and the temperature is 280 ^{0}C. the surface temperature is 250^0 C. Estimate the local heat transfer coefficient at this location and rate of heat transfer.

The thermo-physical properties is SI units are

$\mu = 9.356 \times 10^{-4}$, C_P = 5278, K = 0.5803 13+7

6. a) Show that for fully developed circular pipe flow, the average velocity is half of the maximum velocity and obtain an expression for skin friction coefficient in terms of Reynolds number.

   b) What do you mean by bulk temperature in case of a pipe flow. Explain the calculation of Nusselt number based on bulk temperature.

16+4

Moderate-II