MASTER OF MECH ENGG. EXAMINATION 2018
Second 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.

1. a) Define the significance of Prandtl Number in convective heat transfer. Provide examples where Pr is very high and very low.
   b) Name four factors which affects the transition to turbulence. In each case mention whether critical Re increases or decreases.
   c) Show that limiting value of Nu is 1 for two horizontal plates maintained at constant temperatures, T_u and T_l for upper and lower walls respectively
   d) For fully developed laminar flow in a pipe of 7 cm diameter, find out the flow rate if the maximum velocity in the pipe is 7cm/s.
   e) State the limitations of k-ε model. How turbulent viscosity is expressed in this class of model?

5+4+4+3+4

2. a) Show that coefficient of volumetric thermal expansion is 1/T for an ideal gas.
   b) Sketch the velocity and temperature profiles in the boundary layer for a vertical flat plate under natural convection.
   c) Derive the non-dimensional governing equations for natural convection over a vertical flat plate.

3+3+14

3. 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-diemnsional numbers for boiling along with the expressions.

(12+3)+5

4. a) Briefly discuss the features of a turbulent flow and the RANS procedure. Explain the Reynolds stress term
   b) Explain the role of turbulent Prandtl number in brief.
   c) Isentropic turbulence implies homogeneous turbulence' – comment on this statement and explain if the homogenous turbulent field leads to isentropic turbulence.

12+3+5

5. a) Derive the expression for velocity profile and skin friction coefficient for fully developed flow in a circular duct.

b) Temperature 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. Find out the value of $\overline{T'^2}$

15+5

6 .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) Discuss briefly the differences between natural convection and forced convection. Define modified Rayleigh Number

14+6

7. a) Water flows through a 3 cm diameter tube , 20 m length at the rate of 720 kg/hr. The outside of the tube is heated so as to maintain uniform heat flux. The inlet and exit temperatures are 10^0 and 70^0 respectively. What is the amount of heat flux to water? Estimate the surface temperature of the tube at the exit.

The thermo-physical properties are: $\upsilon = 0.658 \times 10^{-6}$ m^2/s, k = 0.631 W/mK and Pr = 4.32

b) Discuss heat transfer in developing and fully developed pipe flow when the flow is in laminar regime.

c) What do you mean by mixed convection? Provide the guidelines for mixed convection in terms of non-dimensional numbers

11+5+4