Heat Transfer (CH21004)

Assignment – 3

Full Marks – 20 **Due date – 26th February, 2020**

Note: You may use the property table from any standard heat transfer book. Assume any missing data and please mention it.

1. Make a list of all dimensionless numbers you learnt in this course so far. Make a table for their name and expressions in terms of standard symbols. Add a column to the table with their physical significance. Memorize the expression for the following numbers: Re, Nu, Pr, Sh, Sc, Pe, Bi, Fo. Try to reason out the physical significance from the expressions. Note the difference between Bi and Nu.

2. Heated air ($\dot{m} = 0.01$ kg/s) required for a food-drying process is generated by passing ambient air at 20°C through a 5 m long (D = 50 mm) tube. The tube is housed in a steam condenser (T_s = 100°C). Saturated steam at atmospheric pressure is used in the condenser. Determine the outlet temperature of the air.

3. Air at $\dot{m} = 0.0005$ kg/s and 27°C enters a rectangular duct (1 m long, the cross section is 8 mm by 10 mm) on which a uniform surface heat flux of 600 W/m^2 is maintained. What is the temperature of the duct surface at the outlet?
   (Hint: You may need to look for a correlation in the transition region.)

4. Water flows (0.2 kg/s) through a Teflon tube (k=0.35 W/m.K) of inner and outer radii equal to 10 and 13 mm respectively. A thin electrical heating tape wrapped around the outer surface of the tube generates a uniform heat flux of 2000 W/m^2, while a convection current is established in the outside airdue to natural convection (h_o = 25 W/m^{2}K). The ambient air temperature is 300 K. What is the temperature of the outer surface at a location where the mixing cup temperature of water is 290 K? The electrical heating tape may be considered to be of negligible thickness and does not offer any thermal resistance. (*Hint: Use the series resistance concept developed in section 10.2.3 of Middleman*.)

5. Air at 20°C is hydrodynamically fully developed as it flows in a 1 cm I.D. pipe. The average velocity is 0.7 m/s. If it enters a section where the pipe wall is maintained at 60°C, what is the temperature 0.15 m farther downstream?