Total No. of Questions : 8] *[Total No. of Printed Pages : 4*

Roll No.....

MMTP-103

M.E./M.Tech. I Semester,

Examination, June 2017

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 70

Note: i) Answer any five questions.
ii) All question carry equal marks.
iii) Assume suitable data if missing.
iv) Draw neat and clean sketches/diagrams/figures wherever required.

1. a) State and explain basic laws of heat transfer.

   b) Consider a spherical container of inner radius $r_1 = 8$cm, outer radius $r_2 = 10$cm, and thermal conductivity $k = 45$ W/m °C, as shown in figure-1. The inner and outer surfaces of the container are maintained at constant temperatures of $T_1 = 200$°C and $T_2 = 80$°C respectively, as a result of some chemical reactions occurring inside. Obtain a general relation for the temperature distribution inside the shell under steady conditions, and determine the rate of heat loss from the container.

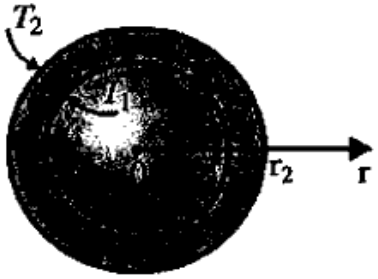

Fig. 1 : Questions 1 (b)

2. A 30m long, 10cm diameter hot water pipe of a district heating system is buried in the soil 50cm below the ground surface, as shown in figure-2. The outer surface temperature of the pipe is 80°C. Taking the surface temperature of the earth to be 10°C and the thermal conductivity of the soil at that location to be 0.9W/m°C, determine the rate of heat loss from the pipe.

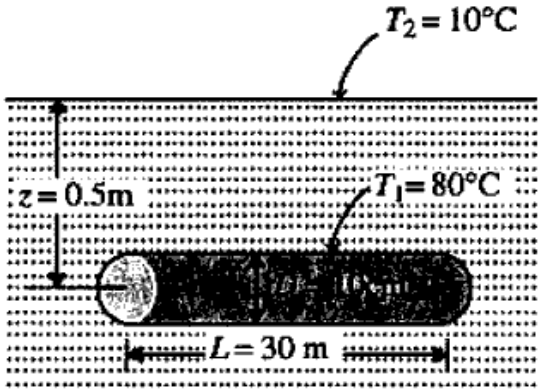

Fig. 2: Question 2

3. a) What is the physical significance of the Prandtl number? Does the value of the Prandtl number depend on the type of flow or the flow geometry? Does the Prandtl number of air change with pressure? Does it change with temperature?

   b) What is Newtonian fluid? Is water a Newtonian fluid? What is forced convection? How does it differ from natural convection? Is convection caused by winds forced or natural convection?

4. A 6cm diameter shaft rotates at 3000rpm in a 20cm long bearing with a uniform clearance of 0.2mm. At steady operating conditions, both the bearing and the shaft in the vicinity of the oil gap are at 50°C, and the viscosity and thermal conductivity of lubricating oil are 0.05N.s/m^2 and 0.17 W/m.K. By simplifying and solving the continuity, momentum and energy equations, determine.

   a) The maximum temperature of oil.

   b) The rates of heat transfer to the bearing and the shaft, and

   c) The mechanical power wasted by the viscous dissipation in the oil,

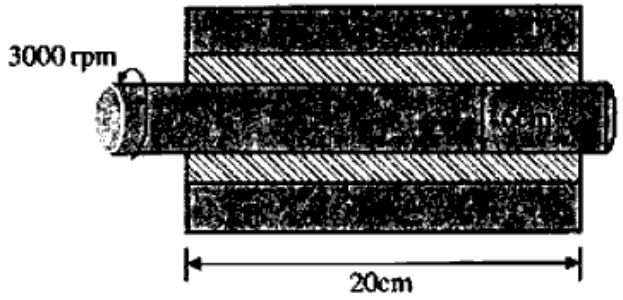

Fig. 3: Question 4

5. a) Define the term boiling. Explain briefly the physical mechanism of boiling.

   b) What is burnout point? Compare film wise and dropwise condensation.

6. a) What geometrical or shape factor? Derive an expression for shape factor in case of radiation exchange between two surfaces.

   b) A 60mm thick plate with a circular hole of 30mm diameter along the thickness is maintained at uniform temperature of 277°C. Find the loss of energy to the surrounding at 20°C, assuming that the two ends of the hole to be as parallel discs and the metallic surfaces and surroundings have black body characteristics.

   a) Define mass transfer. Enumerate its applications. State Fick's law of diffusion and its limitations.

   b) A 20mm deep pan is filled with water to a level of 10mm and is exposed to dry air at 40°C. Determine the time required for all the water to evaporate. Assume the mass diffusivity as 2.6×10^{-5} m^2/s.

Write short notes on the following (any two)

   a) Dimensional Analysis

   b) High heat flux boiling

   c) Types of fins

   d) Boundary layer mass transfer

******