Name ..... Student ID.....

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination Semester I — Academic year : 2005

Date : August 2, 2005 — Time : 9.00 – 12.00 น.

Subject : 230 – 313 Heat Transfer — Room : R 300

1) All notes and books are allowed.

2) There are total 5 questions.

Question	Points value	Score
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	

Name ..... Student ID.....

1. A steam pipe of outside radius r_1 = 4 cm is covered with a layer of asbestos cement of thickness L_1 = 2 cm and thermal conductivity k_1 = 0.2 W/(m.°C) which is covered in turn with a glass wool of thickness L_2 = 5 cm and thermal conductivity k_2 = 0.04W/(m.°C) If the temperature of the outer surface of the pipe is T_1 = 300 °C and that of the outer surface of the glass wool is 30 °C, determine the heat loss per 1-m length of pipe. Assume one-dimensional heat flow, and use the thermal resistance concept. Also give the overall heat transfer coefficient U_0 based on the outside surface of the insulation.

Name ..... Student ID.....

2. Copper-plate fins of rectangular cross section having thickness t = 1 mm, height L = 10 mm, and thermal conductivity k = 380 W/(m.°C) are attached to a plane wall maintained at a temperature T_0 = 235 °C. Fins dissipate heat by convection into ambient air at T = 35 °C with a heat transfer coefficient h = 40 W/(m^2.°C) . Fins are spaced at 10 mm (that is, 100 fins per meter). Assume negligible heat loss from the fin tip.

(a) Determine the fin efficiency.

(b) Determine the net rate of heat transfer per square meter of plane wall surface.

(c) What would be the heat transfer rate from the plane wall if there were no fins attached?

Name ..... Student ID.....

3. Thermal conductivity of a plane wall varies with temperature according to the relation

$$k(T) = k_0(1 + \beta T)$$

where k_0 and β are constants.

(a) Develop an expression for the heat flow through the slab per unit area if the surfaces at $x = 0$ and $x = L$ are maintained at uniform temperatures T_1 and T_2, respectively.

(b) Develop a relationship for the thermal resistance of the wall if the heat transfer surface is A.

(c) Calculate the heat transfer rate through $A = 0.1\ m^2$ of the plate for $T_1 = 200\ ^\circ C$ $T_2 = 0\ ^\circ C$, $L = 0.4$ m, $k_0 = 60\ W/(m.^\circ C)$, and $\beta = 0.25 \times 10^{-4}\ ^\circ C^{-1}$.

Name ..... Student ID.....

4. Water at 20°C is to be heated in a 3 mm- ID tube until the exit temperature reaches 30 °C. The wall temperature is maintained at 50 °C and the inlet flow velocity is 0.4 m/s. Calculate the length of the tube required in meters to accomplish this heating. Also calculate the total heating required, express in watts.

Name ..... Student ID.....

5. Air at 25 °C flows at a speed, U_∞ = 1 m/s over a 20-cm-square plate upon which is imposed a constant heat flux of 20 W/ m^2. Determine (a) the average temperature difference, (b) the temperature difference at the trailing edge, and (c) the average heat-transfer coefficient.