มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

การสอบกลางภาค ประจำภาคการศึกษาที่ 2 ประจำปีการศึกษา 2546

วันที่ 20 ธันวาคม 2546 เวลา 13.30-16.30 น.

วิชา 216-332 Heat Transfer ห้อง A 400

ชื่อ-สกุล…….…….…… รหัส……..

<u>คำสั่ง</u>

ข้อสอบมีทั้งหมด 5 ข้อ ให้ทำทุกข้อ

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ชื่อ-สกุล……..……..…… รหัส……..

1. The inside surface of a brick wall L = 10 cm thick [k_b = 1 W/(m . ^{o}C)] is at temperature T_i = 930^{o}C, and the outer surface is exposed to an ambient at T_∞ = 30^{o}C with a heat transfer coefficient h_o = 20 W/(m^2 . ^{o}C).
   (a) What is the temperature of the outer surface?
   (b) Calculate the thickness of the insulation layer [k = 0.1 W/(m . ^{o}C)] needed on the outer surface such that the surface of the insulation layer exposed to air will not exceed 90^{o}C.

ชื่อ-สกุล……..……...…… รหัส……..

2. Consider a hollow steel sphere of inside radius r_1 = 10 cm and outside radius r_2 = 20 cm. The thermal conductivity of the steel is k = 10 W/(m . ^{o}C). The inside surface is maintained at a uniform temperature of T_1 = 230^{o}C, and the outside surface dissipates heat by convection with a heat transfer coefficient h = 20 W/(m^2 . ^{o}C) into an ambient at T_∞ 30^{o}C.

   Determine the thickness of asbestos insulation [k_i = 0.5 W/(m . ^{o}C)] required to reduce heat loss by 50 percent.

ชื่อ-สกุล……..……...…… รหัส……..

3. A conductor with D = 0.8 cm diameter carrying an electric current passes through an ambient at T_∞ = 30°C with a convection heat transfer coefficient h = 120 W/(m^2 . °C). The temperature of the conductor is to be maintained at T_i = 130°C. Calculate the rate of heat loss per 1-m length of the conductor for

   (a) the conductor bare and

   (b) the conductor covered with Bakelite [k = 1.2 W/(m . °C)] with radius corresponding to the critical radius of the insulator.

ชื่อ-สกุล……..…….……..…… รหัส……..

4. A 3-cm-diameter, stainless-steel ball [ρ = 7865 kg/m^3, C_p = 0.46 kJ/(kg . ^{o}C), and k = 61 W/(m . ^{o}C)] is uniformly heated to T_i = 800^{o}C. It is to be hardened by suddenly dropping it into an oil bath at T_∞ = 40^{o}C. It the quenching occurs when the ball reaches 100^{o}C and the heat transfer coefficient between the oil and the sphere is 700 W/(m^2 . ^{o}C), how long should the ball be kept in the oil bath?

If 100 balls are to be quenched per minute, determine the rate of heat removal form the oil bath per minute needed to maintain its temperature at 40^{o}C.

ชื่อ-สกุล……..……...…… รหัส……..

5. Consider an iron rod $L = 10$ cm long of diameter $D = 1$ cm with thermal conductivity $k = 50$ W/(m . ^{o}C). One end of the rod is maintained at $T_o = 200^{o}$C, the other end at 0^{o}C, while it is exposed to convection from its lateral surfaces into ambient air at 0^{o}C, with a heat transfer coefficient $h = 200$ W/(m^2 . ^{o}C). If we assume one-dimensional, steady-state heat flow, the mathematical formulation of this problem is given by

$$\frac{d^2T(x)}{dx^2} - N^2T(x) = 0 \qquad \text{in } 0 < x < L$$

$$T(x) = 200^{o}\text{C} \qquad \text{at } x = 0$$

$$T(x) = 0^{o}\text{C} \qquad \text{at } x = \text{L}$$

where $N^2 = \frac{Ph}{kA} = \frac{4h}{kD}$

By dividing the region $0 \le x \le L$ into five equal parts, calculate the temperature distribution along the rod, using finite difference.