PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination : Semester II (#2)	Academic Year	:	2002
Date : 12 February 2003	Time	:	13.00-16.00
Subject : 230-630 Advanced Transport Phenomena I	Room	:	ChE

- ข้อสอบมี 6 ข้อ ต้องทำทุกข้อ คะแนนเต็ม 80 คะแนน
- ควรใช้เวลาทำข้อสอบโดยเฉลี่ย 2 นาที/คะแนน
- อนุญาตให้นำหนังสือ เอกสาร เครื่องคำนวณ และอุปกรณ์อื่น ๆ เข้าห้องสอบได้

สุธรรม สุขมณี
ผู้ออกข้อสอบ
10 มกราคม 2546

1) The thermal conductivity of acetylene (C_2H_2) is measured as 0.022 W/m–^{o}C at 1 atm and 25 ^{o}C. Estimate the thermal conductivity at 123.2 atm and 191 ^{o}C. (10 points)

2) Derive an expression for the steady temperature distribution (T) , heat transfer rate (Q) and average temperature ($<T>$) in the hollow solid sphere with a constant thermal conductivity of k, an inside radius of λR and an outside radius of R. The inside temperature of the sphere is T_λ and the ouside temperature is T_R. (25 points)

The average temperature in the sphere is defined as:

$$\langle T \rangle - T_R = \frac{\int_{\lambda R}^{R} (T - T_R)\,dr}{\int_{\lambda R}^{R} dr} = \frac{\int_{\lambda R}^{R} (T - T_R)\,dr}{R(1-\lambda)}$$

3) A very large block of steel with a thermal diffusivity (α) of 1.45 $\times$ 10^{-5} m^2/s is initially at a uniform temperature of 30 ^{o}C. The surface temperature is suddenly raised to 250 ^{o}C. Calculate the temperature in the block at the depth of 25 mm after an exposure time of 30 seconds.(10 points)

4) Air with an uniform temperature of 30 ^{o}C and a pressure of 1.46 atm. (ρ = 1.7 kg/m^3, μ = 0.01822 mPa.s, C_p = 1.022 kJ/kg–^{o}C and k = 0.0266 W/m–^{o}C) is flowing in a smooth circular pipe of diameter 54.1 mm with a mass flow rate of 69.7 kg/h (Reynolds number of about 25000 and the wall shear stress (τ_o) for the flowing air stream may be taken as 0.13 N/m^2). Beginning at z = 0 to z = 2000 mm, there is a heating device that transfer heat to the tube at constant wall heat flux (q_o) of –800 W/m^2. At the distance of 2000 mm from the start of this section, the pipe wall temperature (T_o) is 120 ^{o}C and the time-smoothed air temperature ($\overline{T}$) at the pipe center-line is 87.5 ^{o}C. Find the time-smoothed air temperature ($\overline{T}$) at a distance of 13.525 mm from the pipe wall. (15 points)

5) Air at 40 ^{o}C and 1 atm flows over a flat plate at a velocity of 2 m/s. Calculate the heat flux from the plate at distance of 0.2 and 0.4 m from the leading edge of the plate if the plate is heated over it entire length to a temperature of 60 ^{o}C. (10 points)

Physico-chemical properties of air at 1 atmosphere:

T (^{o}C)	ρ (kg/m^3)	μ (μPa.s)	C_p (kJ/kg–^{o}C)	k (W/m–^{o}C)
40	1.1274	18.588	1.009	0.027
50	1.0925	18.974	1.000	0.028
60	1.0597	19.376	0.994	0.029

6) A 20 mm diameter of horizontal heater is maintained at a surface temperature of 60 ^{o}C and submerged in water at 40 ^{o}C. Calculater the free convection heat loss per unit length of the heater. (10 points)

Physico-chemical properties of water at 1 atmosphere:

T (^{o}C)	ρ (kg/m^3)	μ (mPa.s)	C_p (kJ/kg–^{o}C)	k (W/m–^{o}C)
40	991.5	0.66	4.187	0.637
50	986.5	0.55	4.194	0.649
60	981.6	0.47	4.201	0.660