PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination : Semester II (#1)	Academic Year	:	2003
Date : 21 December 2003	Time	:	13.30-16.30
Subject : 230-630 Advanced Transport Phenomena I	Room	:	R300

- ข้อสอบมี 6 ข้อ จำนวน 11 หน้า ต้องทำทุกข้อ คะแนนเต็ม 80 คะแนน
- ควรใช้เวลาทำข้อสอบโดยเฉลี่ย 2 นาที/คะแนน
- ขอให้นักศึกษาทำข้อสอบในที่ว่างซึ่งได้เตรียมไว้สำหรับข้อสอบแต่ละข้อ โดยอาจใช้เนื้อที่ด้านหลังทำข้อสอบเพิ่มเติมได้
- อนุญาตให้นำหนังสือ เอกสาร เครื่องคำนวณ และอุปกรณ์อื่น ๆ เข้าห้องสอบได้

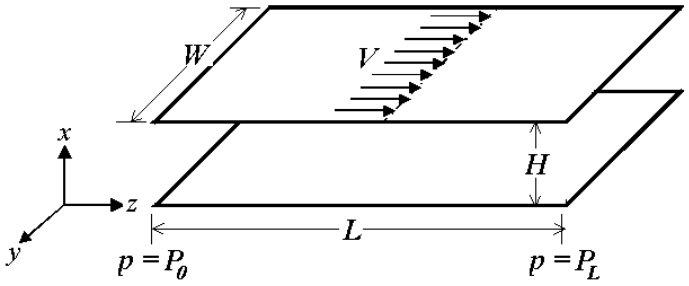
สุธรรม สุขมณี
ผู้ออกข้อสอบ
10 ธันวาคม 2546

1) Soybean oil is confined between two very long, very wide parallel plates. The distance between the plates is 9.14 mm. and the lower plate is being pulled at a relative velocity of 0.366 m/s greater than the velocity of the top plate. The viscosity of the soybean oil is 0.04 Pa.s at 303 K. Make the following calculations:

1.1 Calculate the shear stress and the shear rate. (5 points)

1.2 If glycerol at 293 K having a viscosity of 1.069 kg/m s is used instead of soybean oil, what relative velocity is needed using to achieve the same shear stress? Assume that the gap between the plates remains the same. What is the new shear rate? (5 points)

2) Find the expressions for the velocity profile, $v_z(x)$ and the point of maximum velocity (x which v_z is maximum) for steady, pressure-driven flow of an incompressible Newtonian fluid (constant density and viscosity) between two very long and very wide plates (see below). The top plate is moving at a velocity V; the bottom plate is stationary. One may assume that the gravity effect is negligible and the flow is well developed, that is the disturbances from the entry and exit of the flow are negligible. The pressure at z=0 is P_0, and at z=L the pressure is P_L. The gap between the plates is H, and the width of the flow region of interest is W. (20 points)



- This page is provided for problem #2 -

3) A semi-infinite body of heavy oil with a constant kinematic viscosity ν of 3.45×10^{-4} m^2/s is bounded below by a horizontal surface (the *xz*–plane) initially the oil and the solid are at rest. Then at time $t = 0$, the solid surface is set in motion in the positive *x* direction with velocity 1.0 m/s. There is no pressure gradient or gravity force in the *x* direction, and the flow is presumed to be laminar. After what time will the velocity at the distance of 1 cm. From the solid surface be within 10% and 50% of its final value? (10 points)

4) Experiments with a small-scale agitated tank are to be used to design a geometrically similar installation with linear dimensions of 20 times as large. The fluid in large tank will be a heavy oil with μ = 13.5 cp and ρ = 0.9 g/cm^3. The large tank is to have an impeller speed of 120 rpm.

4.1 Determine the impeller speed for the small-scale model (5 points)

4.2 Determine the kinemetic viscosity of the stirred fluid used in the model (5 points)

- This page is provided for problem #4 -

5) For a pipe (inside diameter = 2.00 in) water at 25°C (density ρ = 62.4 lb_m/ft^3, viscosity $\mu = 6.72\times10^{-4}$ lb_m/ft-s) is made to flow under a pressure drop per unit length of 1.50×10^{-3} psi/in.

5.1 What will be the average velocity of the water in the pipe? (10 points)

5.2 What will be the velocity of water in the pipe at a distance of 0.25 in. from the pipe wall? (10 points)

- This page is provided for problem #5 -

6) For a sphere slowly falling (creeping flow) in a fluid of viscosity μ_1, the terminal velocity of the sphere is v_t. If the same sphere falls in a fluid with the same density but with twice the viscosity ($\mu_2 = 2\mu_1$), what is the terminal velocity of the sphere? Note that the same force (gravity) acts on the sphere in both cases (10 points)