大葉大學 九十二 學年度 研究所碩士班 招生考試試題紙					
系所別	組別	考試科目（中文名稱）	考試日期	節次	備註
機械工程研究所	丁組	材料力學或流體力學	4月13日	第二節 (10:30 ~ 12:00)	可攜帶計算機 P4-1

註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶） 共四頁

＊ 請考生特別注意：請由以下題目中任選 5 題作答（答題數不可超過 5 題，第 6 題（含）以上不予計分）。

1. (20%)

A small rocket, with an initial mass of 400kg, is to be launched vertically. Upon ignition the rocket consumes fuel at the rate of 5 kg/s and ejects gas at atmospheric pressure with a speed of 3500 m/s relative to the rocket. Determine the initial acceleration of the rocket and the rocket speed after 10 s, if air resistance is neglected.

(Hint: Basic equation)

$$F_{B_y} - \int_{CV} a_{rf_y} \rho \, d\mathcal{V} = \frac{\partial}{\partial t}\int_{CV} v_{xyz} \rho \, d\mathcal{V} + \int_{CS} v_{xyz} \rho \vec{V}_{xyz} \cdot d\vec{A}$$

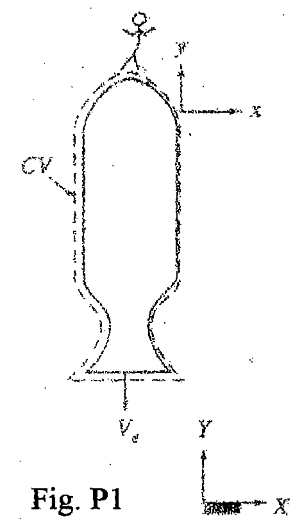

Fig. P1

2. (20%)

A liquid flows down an inclined plane surface in a steady, fully developed laminar film of thickness h. Simplify the continuity and Navier-Stokes equations to model this flow field. Obtain expressions for the liquid velocity profile, the shear stress distribution, the volume flow rate, and the average velocity. Relate the liquid film thickness to the volume flow rate per unit depth of surface normal to the flow. Calculate the volume flow rate in a film of water 1 mm thick flowing on a surface 1 m wide, inclined at 15° to the horizontal.

Basic equations:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

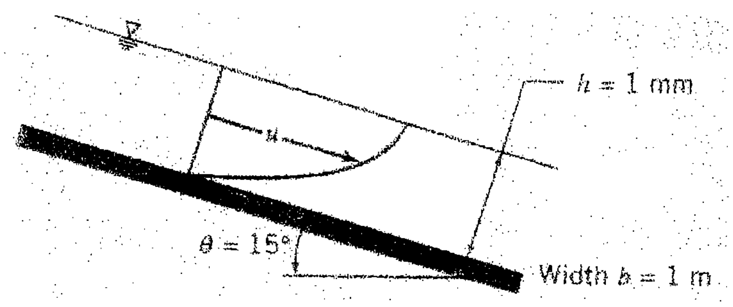

Fig. P2

$$\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right) = \rho g_x - \frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right)$$

$$\rho\left(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z}\right) = \rho g_y - \frac{\partial p}{\partial y} + \mu\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2}\right)$$

$$\rho\left(\frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z}\right) = \rho g_z - \frac{\partial p}{\partial z} + \mu\left(\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2}\right)$$

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機械工程研究所	丁組	材料力學或流體力學	4 月 13 日	第 二 節	可攜帶計算機 P4-2

3. (20%)

Air flows steadily at low speed through a horizontal nozzle, discharging to atmosphere. The area at the nozzle inlet is $0.1 m^2$. At the nozzle exit, the area is $0.02\ m^2$. Determine the gage pressure required at the nozzle inlet to produce an outlet speed of 50 m/s.

Given: Flow through a nozzle, as shown.

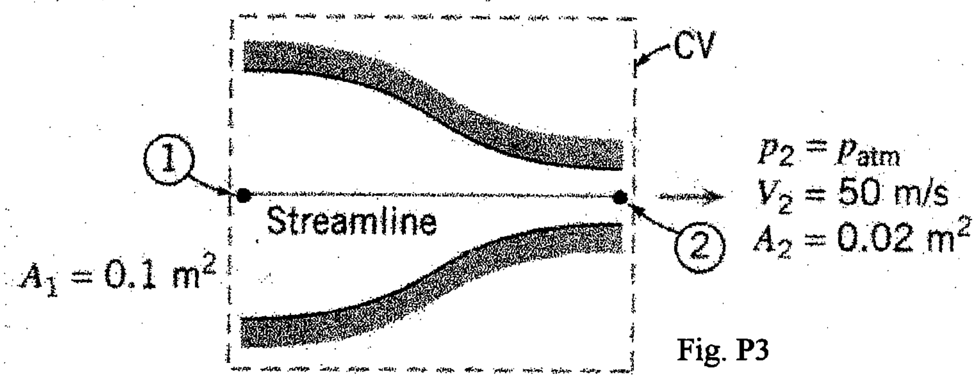

Fig. P3

Basic equation:

$$\frac{p_1}{\rho} + \frac{V_1^2}{2} + gz_1 = \frac{p_2}{\rho} + \frac{V_2^2}{2} + gz_2$$

$$0 = \frac{\partial}{\partial t}\int_{CV} \rho\, d\forall + \int_{CS} \rho \vec{V} \cdot d\vec{A} \quad (=0(1))$$

$\rho = 1.23\ kg/m^3$

4. (20%)

The drag force, F, on a smooth sphere depends on the relative velocity, V, the sphere diameter, D, the fluid density, p, and the fluid viscosity, μ. Obtain a set of dimensionless groups that can be used to correlate experimental data.

Given： $F = f(\rho, V, D, \mu)$ for a smooth sphere.

5. (20%)

The drag of a sonar transducer is to be predicted, based on wind tunnel test data. The prototype, a 1 ft diameter sphere, is to be towed at 5 knots (nautical miles per hour, 1 nautical mile=6080 ft) in sea water. The model is 6 in. in diameter. Determine the required test speed in air. If the drag of the model at test condition is 5.58 lbf, estimate the drag of the prototype.

Sea water : $\rho = 1.99 slug/ft^3, \nu = 1.69x10^{-5} ft^2/s$

Air : $\rho = 0.00238 slug/ft^3, \nu = 1.57x10^{-4} ft^2/s$

6. For the simple beam AB subjected to a uniform load of intensity w=5kN/m over a part of the span shown in Fig. P6, determine (a) the magnitude of the maximum bending moment and (b) the location where the maximum bending moment occurs? (20%)

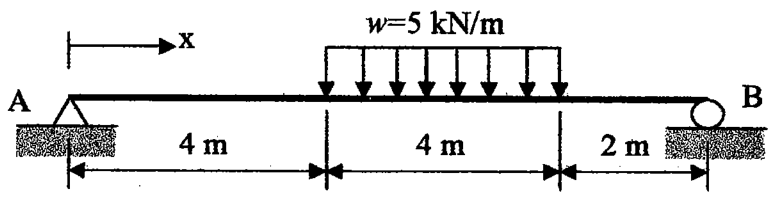

Fig. P6

7. For the uniform beam AB as shown in Fig. P7, (a) derive the equation of deflection curve, (b) determine the slope at B. (Note that the beam is statically indeterminate to the first degree.) (20%)

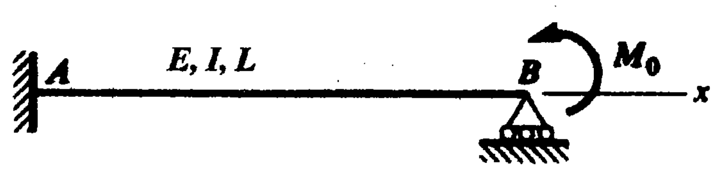

Fig. P7

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8. A solid bar supports a horizontal force P=20kN acting at a distance d=0.2m from the axis of the bar. The length of the bar is h=1.0 m and its diameter is 0.1m. Find the principal tensile stresses and maximum shear stress at point A. (20%)

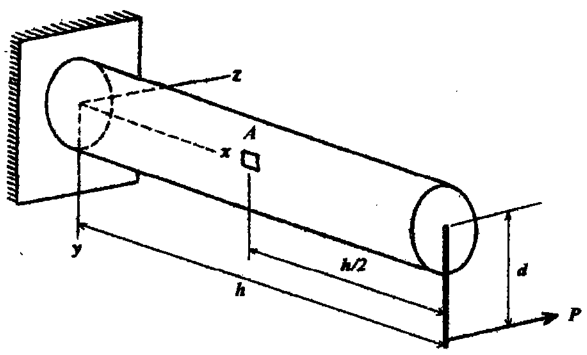
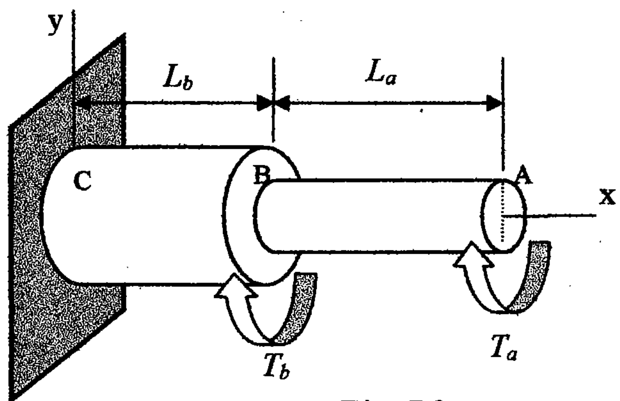


Fig. P8

9. A solid circular shaft AC of two different diameters is attached to a fixed base at C and is subjected to the torques shown in Fig. P9. Derive the equation that represents the twist angle ϕ_A at point A in terms of G, d_a, d_b, T_a, T_b, L_a, L_b. (20%)



G=shear modulus of elasticity
d_a=diameter of section AB
d_b=diameter of section BC

Fig. P9

10. An element in plane stress is subjected to stresses $\sigma_x = 5000N/cm^2, \sigma_y = 3000N/cm^2, \tau_{xy} = 1000N/cm^2$. Determine the principal stresses and principal planes by using Mohr's circle. (20%)

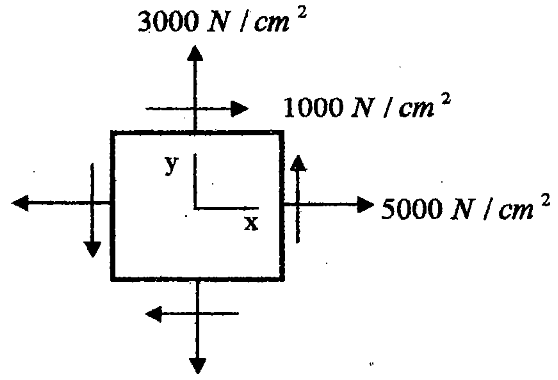


Fig. P10