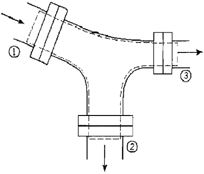
系所組別： 奈米科技暨微系統工程研究所
考試科目： 流體力學
考試日期：0307，節次：2

※ 考生請注意：本試題 ☑可 □不可 使用計算機

1. Please identify the dash line enclosed is a system or a control volume.

(a) Figure 1(a) shows a fluid enters from section 1 and leaves from sections 2 & 3. (5%)

(b) Figure 1(b) shows a piston-cylinder four-stroke engine with inlet and outlet during operation (5%)



(a)

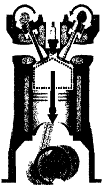

(b)

Figure 1

2. Water with density ρ=1000 Kg/m^3 flows steadily through a two dimensional, square channel of constant width, h=75.5mm, with uniform velocity, U, as shown in Figure 2. The channel makes a 90° bend that distorts the flow to produce the linear velocity profile shown at the exit, with $\mathcal{V}_{max}=2\mathcal{V}_{min}$,

(a) Evaluate $\mathcal{V}_{min}$ if U=7.5m/s (5%)

(b) Flow at inlet is at P_1=84 KPa (gage). Flow at the exit is non-uniform, and at atmospheric pressure. The mass of channel structure is Mc=2.05kg; the internal volume of the channel is 0.00355 m^3 Evaluate the force exerted by the channel assembly on the supply duct. (20%)

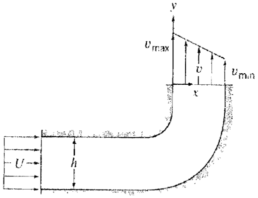


Figure 2

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

3. The continuity equation and Navier-Stokes Equations for Newtonian fluid are given below.

$$\frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$$

$$\rho\frac{Du}{Dt}=\rho g_x-\frac{\partial p}{\partial x}+\frac{\partial}{\partial x}\left[\mu\left(2\frac{\partial u}{\partial x}-\frac{2}{3}\nabla\cdot\vec{V}\right)\right]+\frac{\partial}{\partial y}\left[\mu\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right)\right]+\frac{\partial}{\partial z}\left[\mu\left(\frac{\partial w}{\partial x}+\frac{\partial u}{\partial z}\right)\right]$$

$$\rho\frac{Dv}{Dt}=\rho g_y-\frac{\partial p}{\partial y}+\frac{\partial}{\partial x}\left[\mu\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right)\right]+\frac{\partial}{\partial y}\left[\mu\left(2\frac{\partial v}{\partial y}-\frac{2}{3}\nabla\cdot\vec{V}\right)\right]+\frac{\partial}{\partial z}\left[\mu\left(\frac{\partial v}{\partial z}+\frac{\partial w}{\partial y}\right)\right]$$

$$\rho\frac{Dw}{Dt}=\rho g_z-\frac{\partial p}{\partial z}+\frac{\partial}{\partial x}\left[\mu\left(\frac{\partial w}{\partial x}+\frac{\partial u}{\partial zx}\right)\right]+\frac{\partial}{\partial y}\left[\mu\left(\frac{\partial v}{\partial z}+\frac{\partial w}{\partial y}\right)\right]+\frac{\partial}{\partial z}\left[\mu\left(2\frac{\partial w}{\partial z}-\frac{2}{3}\nabla\cdot\vec{V}\right)\right]$$

(a) The $\frac{Du}{Dt}$ term is called as substantial or material derivative. Please describe the physical meaning of the derivative and expand the $\frac{Du}{Dt}$ term (5%)

(b) For incompressible flow, please rewrite the continuity equation. (5%)

(c) Please reduce the Navier-Stokes equations above and write down the Navier-Stokes equations under incompressible flow with constant viscosity conditions. (5%)

(d) Please reduce the Navier-Stokes equations above and write down the Navier-Stokes equations under incompressible and inviscid flow with constant viscosity conditions. (5%)

(e) What is called for the simplified Navier-Stokes equation in problem 3(d)? (5%)

4. Consider two-dimensional, steady, incompressible flow through the convergent channel in Figure 3. The velocity on the horizontal centerline (x-axis) is given by $\vec{V}=V_1[1+(x/L)]\vec{i}$

(a) Find the acceleration of particle moving along the centerline. (5%)

(b) For particle, located at x=0 at t=0, find the particle position x_p as a function of time. (5%)

(c) Use position $x_p(t)$ in problem 4(b), find out the particle acceleration a_p as a function of time. (5%)

(d) Compare the particle acceleration at x=L by using solutions in problem 4(a) and 4(c). (5%)

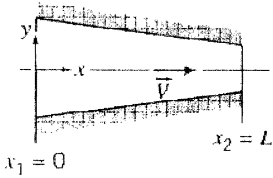


Figure 3

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

5. As shown in Figure 4, the Couette flow is a steady state flow between two parallel flat plates, where the upper plate moves to the right with a constant velocity $u(H) = U_2$ and the lower plate moves to the left with a constant velocity $u(0) = -U_1$

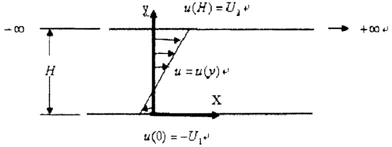


Figure 4

(a) From governing equations of the steady two-dimensional incompressible flow, derive the necessary governing equation for the Couette flow by assuming $\partial(.)/\partial x = 0$ (10%)

(b) The velocity field is $\vec{v} = u\vec{i} + v\vec{j}$, find out velocity profile of $u = f(y/H)$, , where H is the distance between two parallel plates. (10%)