國立成功大學 106 學年度碩士班招生考試試題

系　所：水利及海洋工程學系

考試科目：流體力學

考試日期：0213，節次：1

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

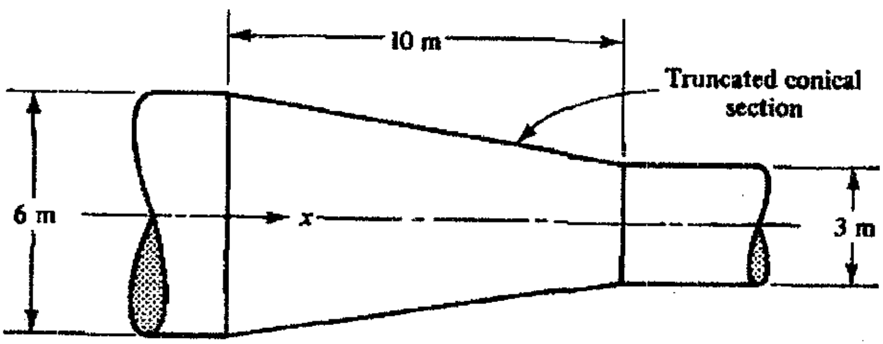
1. (16%) Write a short, qualitative definition of the following terms:
   (a) Inviscid flow
   (b) Incompressible flow
   (c) Irrotational flow
   (d) Velocity potential
   (e) Boundary layer
   (f) Turbulent flow
   (g) Drag
   (h) Buckingham Pi Theorem

2. (20%) Calculate the vorticity at any point (R, θ) for each of the following two-dimensional flow fields:
   (a) $u_R = 0$, $u_\theta = \Omega R$,
   (b) $u_R = 0$, $u_\theta = \frac{\Gamma}{2\pi R}$,
   (c) Calculate the circulation for case (b) and discuss the results in terms of circulation and vorticity

   Where R and θ are cylindrical coordinates, Ω (angular velocity) and Γ (circulation) are constants. Note that the in cylindrical coordinates (R, θ, Z)

   $\nabla \times \mathbf{u} = \left(\frac{1}{R}\frac{\partial(Ru_\theta)}{\partial R} - \frac{1}{R}\frac{\partial u_R}{\partial \theta} \right) \mathbf{e}_z$

3. (20%) Consider the following transition section:



   (a) The flow from left to right is constant at $Q = 12\pi$ m^3/s. What is the total acceleration of a water particle in the x direction at $x = 5$m? Assume that the water is incompressible and that the x component of velocity is uniform across each cross section.

   (b) The flow of water from *right* to *left* is given by

   $Q(t) = \pi t^2$

   Calculate the total acceleration at $x = 5$ m for $t = 2.0s$. Make the same assumptions as in part (a).

4. (20%) If the water (assumed inviscid) in the U-tube is displaced from its equilibrium position, it will oscillate about this position with its natural period. Assume that the displacement of the surface is

$\eta(t) = A\cos\frac{2\pi}{T}t$

where the amplitude A is 10 cm and the natural period T is 8 s. What will be the pressure at a distance 20 cm below the instantaneous water surface for $\eta = +10$, 0, and -10 cm? Assume that $g = 980$ cm/s^2 and $\rho = 1$ g/cm^3.

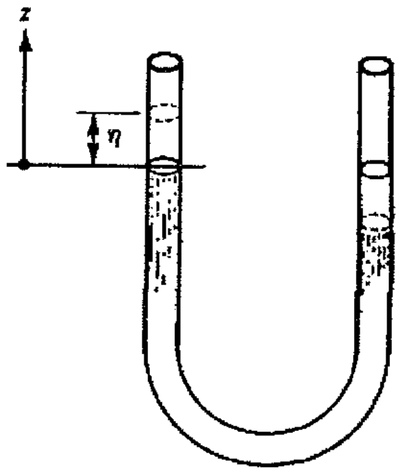


Figure 1: sketch of problem 4

5. (24%) Consider steady flow between two parallel inclined plates, driven by both constant pressure gradient (dp/dx) and gravity. The distance between the two plates is $2H$ and the chosen system of coordinates is shown in Fig. 2. The angle formed by the two plates and the horizontal direction is θ. Calculate velocity component in x-direction (i.e. u_x) and pressure.

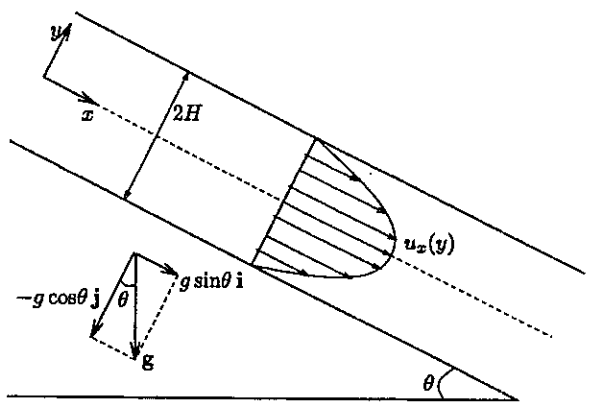


Figure 2: Poiseuille flow between inclined plates