國立成功大學 106 學年度碩士班招生考試試題

系　　所：航空太空工程學系

考試科目：流體力學

考試日期：0213，節次：2

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

1. (20%) Ball, $m = 0.1kg$,　released from rest at $y_0 = 200m$. y is the height position of the ball.

   Air resistance, $F_D = kV^2$, where $k = 10^{-4} N \cdot s^2 / m^2$, V is the velocity of the ball, and the gravity, $g = 9.8m/s^2$

   (a) Find the total force acting on the ball at each time, *t*.

   (b) Now, set the velocity, *V*, is also a function of *y* and $\frac{dV}{dt} = \frac{dV}{dy}\frac{dy}{dt} = V\frac{dV}{dy}$

   Find the ordinary equation for the velocity at each position, *y*, and solve the solution of the ODE.

   (c) Find the speed at which the ball hits the ground, $y = 0m$.

2. (20%) Consider the two-dimensional flow field defined by the following velocity components, (u,v):

   $$u = x, \qquad v = -y$$

   For this flow field find the equation of:

   (a) The streamline through the point (1,1) at $t=0$

   (b) The patheline for a particle released at the point (1,1) at $t=0$

   (c) The steakline at $t = 0$　which passes through the point (1,1).

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3. Consider the two-dimensional fluid flow with velocity components:

$$u = ax + bx^2 + cy \ ; \ v = dy + exy$$

where a, b, and c are constants greater than zero.

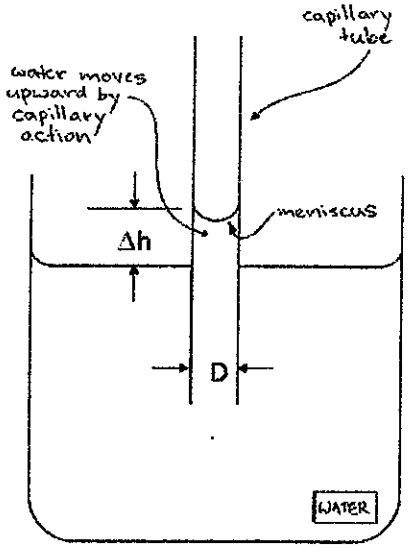
(a) Assume density is constant and the mass is conserved, what can be said about constant d and e. (7%)

(b) Determine if the vorticity is zero somewhere in the flow field. Is this flow an irrotational flow? (7%)

(c) Find the rate of angular deformation in xy plane of this flow field? (6%)

4. When a small tube is dipped into a pool of liquid, surface tension causes a meniscus to form at the free surface, which is elevated or depressed depending on the contact angle at the liquid-solid-gas interface. Experiments indicate that the magnitude this capillary effect △h, is function of the tube diameter D, liquid specific weight γ and the surface tension σ. Determine the number of independent non-dimensional parameters by using dimensional analysis. (20%)

Hint: The dimension of surface tension σ is force per unit length.



5. Figure below shows a flow between a rotating inner cylinder (radius $r=R_i$) with angular velocity ω and stationary outer cylinder (radius $r=R_o$) inside a rotational viscometer. Assume the flow can be modelled as Couette flow since the gap is so small and the density and viscosity of the fluid is ρ and μ. Please answer the following questions:

(a) Derive the steady state velocity field $U=f(r)$ between at $r=R_o$ and $r=R_i$? (10%)

(b) If the viscometer cylinder height is L, find out the total torque ($T_{viscous}$) acting on the inner cylinder wall due to fluid viscosity. (5%)

(c) Derive the viscosity (μ) in terms of total torque ($T_{viscous}$) acting on the inner cylinder, cylinder height (L), angular velocity (ω), outer radius (R_o) and inner radius (R_i). (5%)