國立成功大學 105 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：0227，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. (a) For the compound differential manometer in the Figure 1(a), calculate P_A-P_B=? (10%)

Hint: Oil specific gravity (sg)=0.9, mercury specific gravity (sg)=13.54, density of water (ρ)=1000 Kg/m^3, acceleration due to gravity (g)=9.81 m/s^2

(b) The inclined surface, as shown in Figure 1(b), hinged along edge A, is 2 m wide. Determine the necessary moment with respect to edge A, M_A to open the gate. The other shape conditions are $\theta = 45^0$, $z_A = -5\,\text{m}$, $d_{AB} = 6\,\text{m}$. (10%)

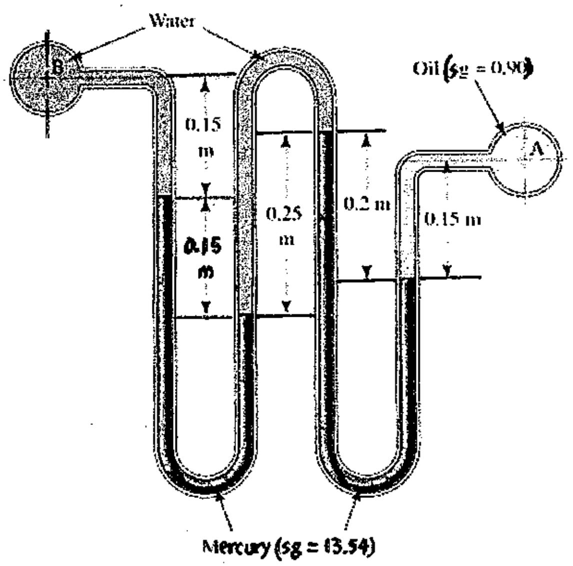


Figure 1(a)

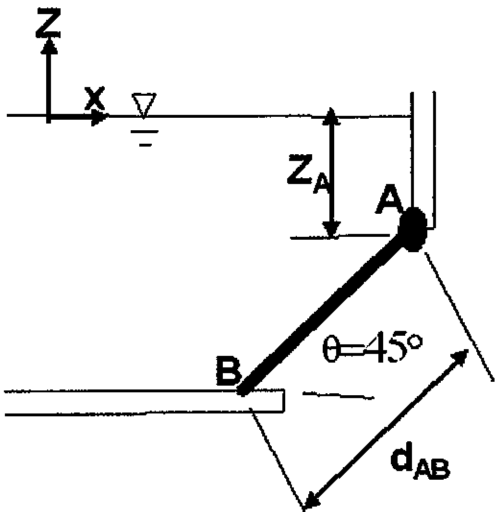


Figure 1(b)

2. A circular plate is forced down at a steady velocity U_0 against a flat surface. Frictionless incompressible fluid of density ρ fills the gap h(t). Assume that $h \ll r_o$, the plate radius, and that the radial velocity $u_r(r, t)$ is constant across the gap.

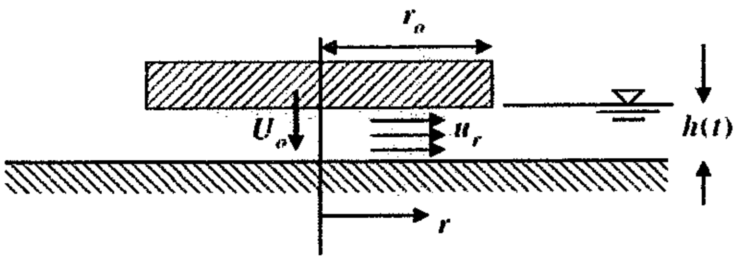
a) On examining the flow under this disk, please write the governing equations (continuity equation and momentum equation) of this problem. (6%)

b) Write the boundary conditions required. (2%)

c) Obtain a formula for $u_r(r, t)$ in terms of r, U_o, and h. (4%)

d) Determine $\partial u_r(r, t)/\partial t$. (4%)

e) Calculate the pressure distribution under the plate assuming that $p(r = r_o)=0$. (4%)



3. A 2D wall moves upward with velocity $V_0\hat{j}$, where $\hat{j}$ is the unit vector in y direction. There is a thin film of water attached on the wall surface as shown in the figure. The gravity tends to move the water downward, while the wall surface tends to drag the water upward by viscosity. Assume that the flow is steady, incompressible, laminar and that the pressure is a constant P_{atm} everywhere. The continuity equation and the y-momentum equation are

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

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

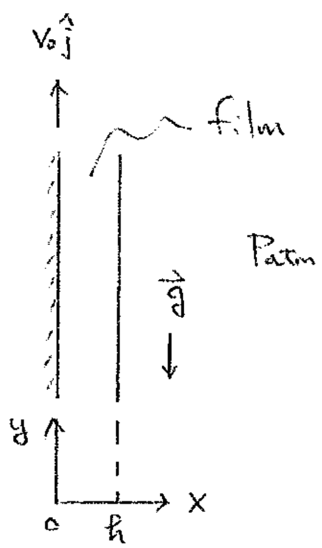
where density ρ is a constant, u and v are the Cartesian velocity component in x and y direction, p is pressure, μ is molecular viscosity, g is gravity constant. Assume that the film flow is fully developed in y direction, and the velocity is $\vec{v}=v(x)\hat{j}$ with $u = 0$.

(a) Verify whether or not the given velocity field $\vec{v}=v(x)\hat{j}$ is incompressible. (3%)

(b) Assume that the atmosphere produces no shear stress at the outer surface of the film. What is the boundary condition for $v(x)$ at x = 0 (wall surface) and x = h (outer film surface)? (6%)

(c) Simplify the momentum equation in y direction to obtain an equation for $v(x)$. (6%)

(d) Solve $v(x)$ and determine the speed $v(h)$ on the outer film surface at x = h. (5%)



4. Show the dimension of viscosity in SI units. Describe a method to measure the viscosity of a fluid, for instance, air or water. (20%)

5. A water jet pump has jet area 0.009 m^2 and jet speed 30.5 m/s. The jet is within a secondary stream of water having speed $V_s = 3\ m/s$. The total area of the duct (the sum of the jet and secondary stream areas) is 0.07 m^2. The water is thoroughly mixed and leaves the jet pump in a uniform stream. The pressures of the jet and secondary stream are the same at the pump inlet. Determine the speed at the pump exit and the pressure rise, $p_2 - p_1$. (20%)