淡江大學八十七學年度碩士班入學考試試題

系別： 航空太空工程學系 科目： 流體力學

本試題共 / 頁

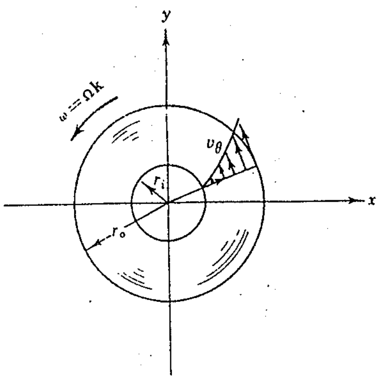
1. (20%) (a)Please explain the leading edge and trailing edge stalls, (b)Is this anything to do with a flying kite? (c)Now, how do you explain why a kite can fly?

2. (20%) (a)Please prove the existence of an incompressible flow whose velocity is given by $V = -2y/(x^2 + y^2)\, i + 2x/(x^2 + y^2)\, j$
(b) Compute the pressure gradient at $(x, y) = (3, 2)$ for $\rho = 0.2\ slug/ft^3$. Note that x and y are in feet, V in feet/sec. [Specify the unit with each answer]

3. (20%) The complex potential for the flow around a sharp edge, such as the edge of a flat plate, is $F(z) = cz^{1/2}$, where c is real.
Please find the velocity components in cylindrical coordinates and sketch the streamlines.

4. (20%) A plane flying at 800m height with Mach number 2.0 was just over my head when I was on top of a 50m height building. If the temperature around is 32°C, how long do I have to wait to hear the sound of the plane? [assume the universal gas constant to be 287 Nm/KgK]

5. (20%) The cross section of two long concentric circular cylinders is shown in the figure. The annular space between the two cylinders is filled with a viscous fluid of density ρ and dynamic viscosity μ. The outer cylinder is rotated at a constant angular velocity $\omega = \Omega k$ while the inner cylinder is held stationary. The fluid motion in the annular space is axially symmetric.
(a) From the Navier-Stokes equations please find the differential equation of motion.
(b) For shear stress $\tau_{r\theta} = \mu r \dfrac{\partial (v_\theta / r)}{\partial r}$, please determine the torque per unit length about the axis of the cylinders due to shear forces acting on the surface of the inner cylinder.



r-component:

$$\rho\left(v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} - \frac{v_\theta^2}{r} + v_z \frac{\partial v_z}{\partial z} + \frac{\partial v_z}{\partial r}\right)$$
$$= \rho g_r - \frac{\partial p}{\partial r} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r} r v_r\right) + \frac{1}{r^2}\frac{\partial^2 v_r}{\partial \theta^2} - \frac{2}{r^2}\frac{\partial v_\theta}{\partial \theta} + \frac{\partial^2 v_r}{\partial z^2}\right]$$

θ-component:

$$\rho\left(v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r v_\theta}{r} + v_z \frac{\partial v_\theta}{\partial z} + \frac{\partial v_\theta}{\partial t}\right)$$
$$= \rho g_\theta - \frac{1}{r}\frac{\partial p}{\partial \theta} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r} r v_\theta\right) + \frac{1}{r^2}\frac{\partial^2 v_\theta}{\partial \theta^2} + \frac{2}{r^2}\frac{\partial v_r}{\partial \theta} + \frac{\partial^2 v_\theta}{\partial z^2}\right]$$

z-component:

$$\rho\left(v_r \frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta} + v_z \frac{\partial v_z}{\partial z} + \frac{\partial v_z}{\partial t}\right)$$
$$= \rho g_z - \frac{\partial p}{\partial z} + \mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r \frac{\partial v_z}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 v_z}{\partial \theta^2} + \frac{\partial^2 v_z}{\partial z^2}\right]$$