Ö. Savaş NAME:

8:10-9:00, Friday, February 25, 2011

ME 106 FLUID MECHANICS

EXAM 1 – open class notes and bspace notes, no external communication

1. (20+5=25%) The Pitot-static tube of an A380 jumbo jet flying at 13 km altitude, its stated service ceiling, in standard atmosphere is reading a pressure differential of 1.0×10^4 Pa. You may consult the table in your class notes for atmospheric data.

(a) Determine the speed of the aircraft.

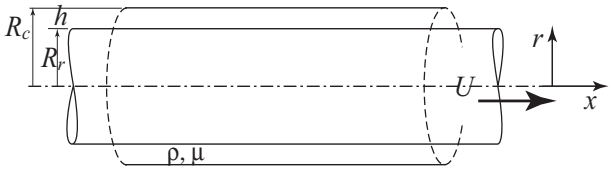
(b) Determine the Mach number of the aircraft.

2.(20+5=25%) Construct and sketch the streamline equation for the flow field given in cylindrical coordinates

$$\mathbf{u} = (u_r, u_\theta) = \left(\cos\theta, \frac{1}{r} - \sin\theta \right)$$

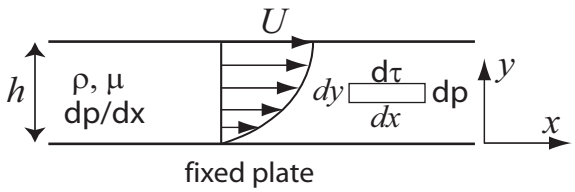
Hint: remember the chain rule; $d(fg) = g\ df + f\ dg$

3. (25%) Determined the force per unit length required to pull at velocity U a rod of radius R_r out of a cylinder of inner radius R_c filled with an oil of viscosity μ. The rod and the cylinder are concentric. The gap between them $h = (R_c - R_r)$ is much smaller than their diameters, $h/R_c < h/R_r \ll 1$ so that you may wish to use planar flow approximation. Of course, you are always welcome to use the exact solution developed in class, but at your own peril!



4.(10+10+5=25%)

Consider the flow fluid of viscosity μ between two parallel infinite plates which are h apart. The top plate is moving to the right at constant velocity of U in its plane and the bottom plate is fixed. There is a constant negative pressure gradient of $dp/dx < 0$ acting on the fluid in the gap. Determine the value of $P = dp/dx$ for which the shear stress on the top plate vanishes.



Hint: Write the force balance for an infinitesimal fluid strip and apply the boundary conditions as you go along when integrating.