1. Multiple choice (25%, 5% each)

(1) The velocity field of a steady state, incompressible fluid is expressed as $\vec{V} = (0.6 + 0.5x)\vec{i} + (1.2 - 0.5y)\vec{j}$ m/s, where x and y are position in m. Determine the stagnation position of the fluid.

(a) (0.5, −0.5) m　(b) (−1.2, 2.4) m　(c) (0, 0) m

(d) No stagnation position　(e) None of above

(2) In problem (1), determine the acceleration of the fluid at the position (0, 0).

(a) (−1.2, 2.4) m/s^2　(b) (0, 0) m/s^2　(c) (0.3, −0.6) m/s^2

(d) (0.5, −0.5) m/s^2　(e) None of above

(3) Which of the following velocity fields is in steady state? For all the following velocity fields, a and b are constant; x, and y are position; t is time.

(a) $\vec{V} = ax^2\vec{i} - by^2\vec{j}$　(b) $\vec{V} = ax\vec{i} - (by + t)\vec{j}$　(c) $\vec{V} = 2a\vec{i} + bt\vec{j}$

(d) $\vec{V} = ax\vec{i} - bxt\vec{j}$　(e) None of above

(4) For a given velocity field $\vec{V} = u\vec{i} + v\vec{j}$, where u and v are given in the followings. Which one is incompressible flow field?

(a) $u = xt + 2y,\ v = 2x - yt^2$　(b) $u = 3x + y,\ v = x - y^3$　(c) $u = xt^2,\ v = xyt + 2y^2$

(d) $u = x + y,\ v = x - y$　(e) $u = x + 2y,\ v = x^2 - y^2$

(5) A stream function of a flow field is given as $\psi = x^2 - y^2$. The velocity field is

(a) $\vec{V} = -2y\vec{i} + 2x\vec{j}$　(b) $\vec{V} = -2x\vec{i} - 2y\vec{j}$　(c) $\vec{V} = -2y\vec{i} - 2x\vec{j}$

(d) $\vec{V} = 2x\vec{i} - 2y\vec{j}$　(e) None of above

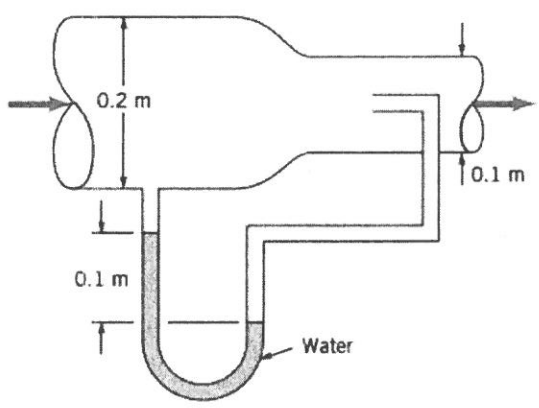
2. To determine the drag on an airplane cruising at 400 km/h in standard air, engineers conduct an experiment on a 1:10 scale model placed in a pressurized wind tunnel. (25%)

(a) Determine the required pressure in the tunnel (assuming the same air temperate for model and actual airplane) (15%)

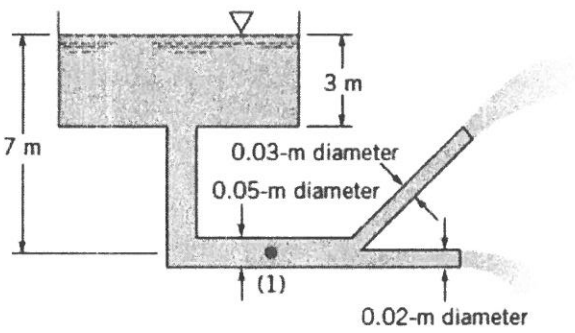
(b) Determine the drag on the airplane corresponding to a measured force of 5N on the model. (10%)

3. Air flows steadily through the variable area pipe shown below. Determine the flowrate if viscous and compressibility effects are negligible. (15%)

(Let $\gamma_{air} = 12.0\ \text{N/m}^3, \gamma_{water} = 9800\ \text{N/m}^3, g = 9.81\,\text{m/s}^2$)



4. Water flows from a tank through a pipe that splits into two smaller pipes as shown in the following figure. If viscous effects are negligible, determine the flowrate from the tank and the pressure at point (1). (15%) (Let $\gamma_{water} = 9800\ \text{N/m}^3, g = 9.81\,\text{m/s}^2$)



5. The velocity components for steady flow through the nozzle shown are

$$u = -V_0 x/\ell \quad \text{and} \quad v = V_0\left[1+(y/\ell)\right]$$

where V_0 and ℓ are constants. Determine the ratio of the magnitude of the acceleration at point (1) to that at point (2). (20%)