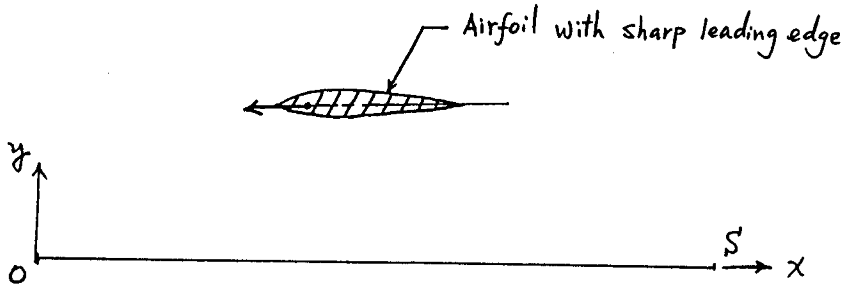
1. A 2-D airfoil is moving at a constant speed through the air initially at rest, It has a sharp leading edge and we assume that the air is inviscid. Let S be a reference surface under this airfoil and moving along with it.

5% (a) If the flow is incompressible, check the momentum balance of the flowfield using S as one of the control surfaces. Sketch the horizontal component of momentum flux through the surface S, versus the x axis, and the pressure distribution on the surface S.

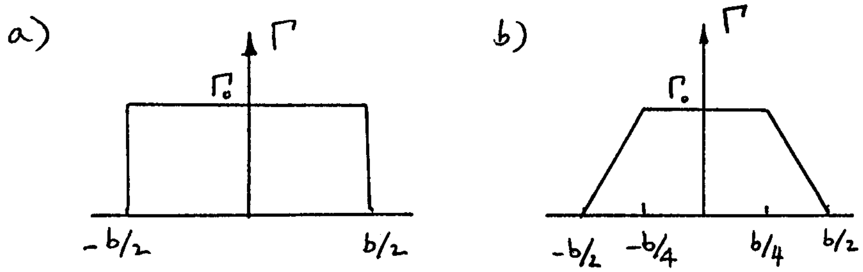
5% (b) Same as (a), if the airfoil is at a subsonic speed.

5% (c) Same as (a), if the airfoil is at a supersonic speed.

5% (d) Discuss the differences between the cases of (a), (b) and (c).



2. If the load distributions on a finite-span wing are as shown, respectively in Figures (a) and (b), sketch the trailing vortex system, indicating the magnitude and direction of the trailing vortices. 20%

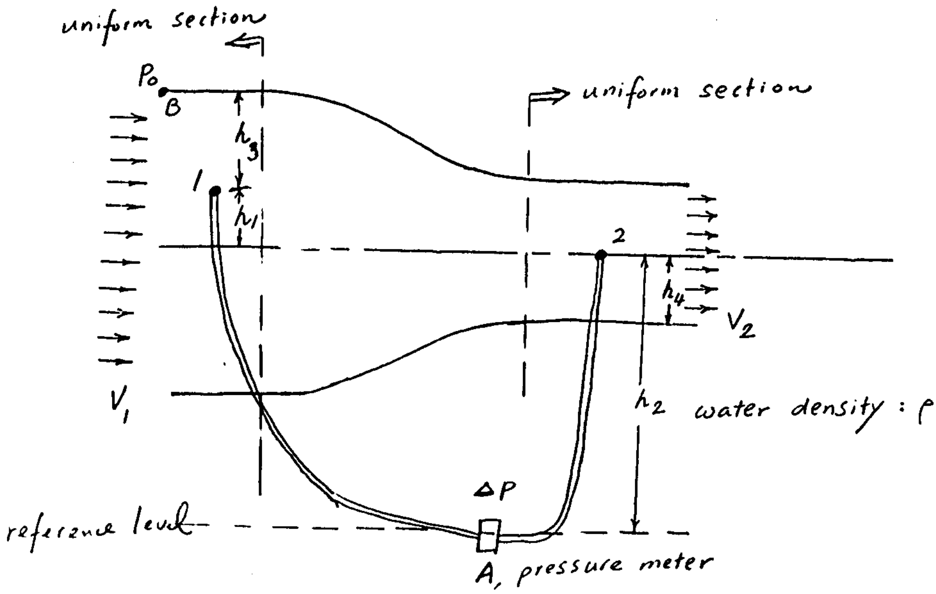


(Γ: circulation
b: half wing span)

3. Water flows through a symmetric, two-dimensional contraction duct. Assume that the viscous effect is negligible and flow speed is uniform at every cross section. As the figure shown, pressure difference measured at point A is ΔP, where the tubes are connected to the points 1 and 2 respectively. The reference pressure measured at point B is P_0.

6% (a) Sketch the streamlines through points 1 and 2.

14% (b) Find velocity V_2 in terms of the parameters given in the figure.



4.

(a) Use Fig.1 prove that the continuity equation and momentum equations

10% for incompressible inviscid steady one dimensional flow are

$$\frac{dV}{V} + \frac{dA}{A} = 0$$

$$dP + \rho V\, dV = 0$$

(b) Use Fig.2 find the velocity and acceleration at exit. The channel

10% cross sectional **area** is $A = [1 + 0.2\, x/L - 0.02\,(x/L)^2]\, m^2$, $L = 10$ cm,

The inlet velocity is $V_0 = 5$ m/s and $\rho = 1.23$ kg/m^3.

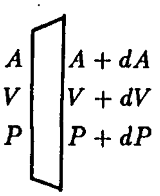


Fig.1

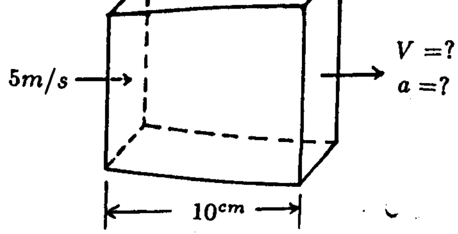


Fig. 2

5. Two infinitely large parallel plates, as shown in the figure, form
20% a channel through which an incompressible fluid flows laminarly at a mass flow rate of $\dot{m}$ in the X-direction. Also, the bottom plate is stationary and the top one, which is a distance H in the y-direction above it, moves with velocity U_o at an angle, θ degrees, from the X-axis toward the Z-axis. Assuming that the flow is steady and fully-developed, calculate the velocity distributions for U, V and W in the three directions.