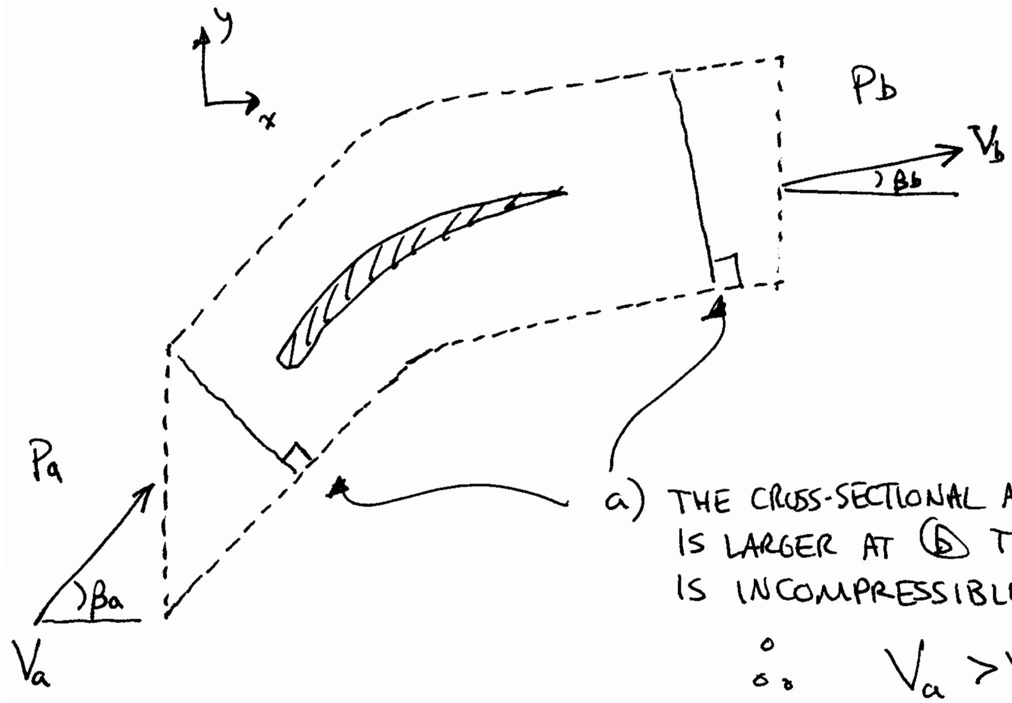

a) THE CROSS-SECTIONAL AREA OF THE STREAMTUBE IS LARGER AT (b) THAN AT (a). SINCE FLOW IS INCOMPRESSIBLE, ρ = CONST.

$\therefore \quad V_a > V_b$

b) STEADY FLOW, NO ACCEL OF C.V.

$$\sum F_x = R_x + \int_S p\,dS = \int_S \rho u_x \vec{u}\cdot\vec{n}\,dS$$

NOTES: a) BY SYMMETRY PRESSURE FORCES ON UPPER AND LOWER STREAMSURFACES WILL BALANCE $\therefore$ ONLY NEED TO CONSIDER PRESSURE FORCES ON LEFT AND RIGHT SURFACES OF C.V.

b) SINCE UPPER AND LOWER SURFACES ARE STREAMLINES (EVERYWHERE PARALLEL TO FLOW) THERE IS NO FLUX ACROSS THEM. NEED ONLY CONSIDER FLUX TERMS ON LEFT AND RIGHT SURFACES OF C.V.

$$R_x + p_a S - p_b S = \rho V_a \cos\beta_a(-V_a\cos\beta_a)S + \rho V_b\cos\beta_b(V_b\cos\beta_b)S$$

MASS FLOW THROUGH SURFACE AT (a) $= \rho V_a \cos\beta_a S$

MASS FLOW THROUGH SURFACE AT (b) $= \rho V_b \cos\beta_b S$

MUST BE EQUAL SINCE NO OTHER FLUXES IN OR OUT OF C.V.

$\therefore \quad R_x = (P_b - P_a)S$ = force on C.V., meaning force on blade is $\leftarrow$ DIRECTION

$$\sum F_x = R_y + \underbrace{\cancel{\int_S p\, dS}}_{0} = \int_S \rho u_y \vec{u}\cdot\vec{n}\, dS$$

No y-force on left & right surfaces & pressures on top & bottom surfaces are equal

$$R_y = \rho V_a \sin\beta_a \left(-V_a \cos\beta_a\right) s + \rho V_b \sin\beta_b \left(V_b \cos\beta_b\right) s$$

$$R_y = \rho s V_a \cos\beta_a \left[V_b \sin\beta_b - V_a \sin\beta_a\right] \qquad (< 0)$$

= FORCE ON C.V.

∴ FORCE ON BLADE IS IN + y - DIRECTION