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استاتيكا
دوائر كهربية
الكترونيات
ميكانيكا الانشائات
هيدروليكا
مدرس خصوصي
اونلاين
حضوري
يحصل الطالب علي
. مقاطع فيديوهات لشرح المقرر بشكل وافي
. ملخص للمادة Pdf للمذكرة والمراجعة
. محاضرات مباشرة علي برنامج زووم
لمناقشة الأجزاء الغير مفهومة
. تواصل مستمر مع معلم المادة
للتواصل
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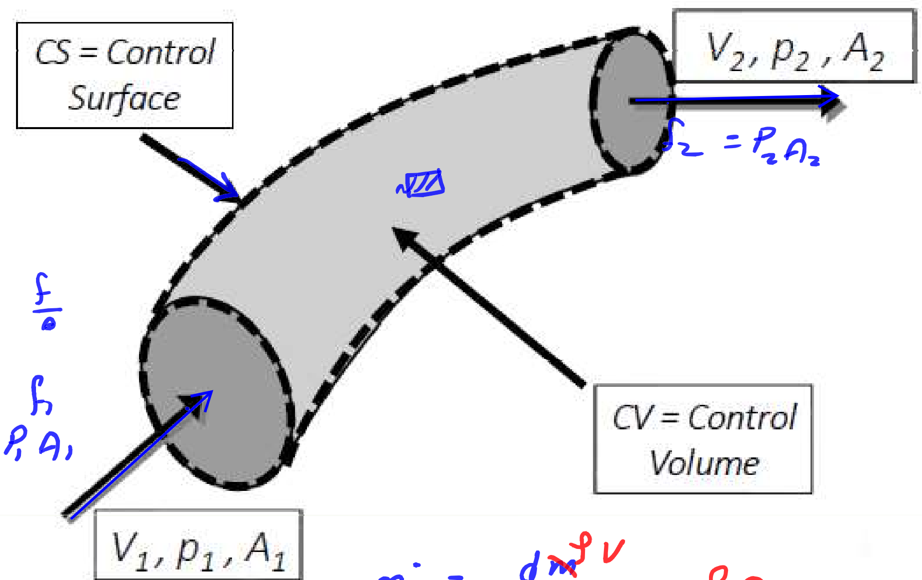
HYDRAULICS (2)

DEVELOPMENT OF THE MOMENTUM PRINCIPLE



$$F = \dot{m}(\vec{V}_{out} - \vec{V}_{in})$$

$$F = \rho Q\ (\vec{V}_{out} - \vec{V}_{in})$$

$$\sum \vec{F} = \dot{m}\ (\beta_2 \vec{V}_2 - \beta_1 \vec{V}_1)$$

PROBLEMS SOLVING TECHNIQUE

Steps in Analysis:

1. Draw a control volume
2. Decide on co-ordinate axis system
3. Calculate the surface forces
4. Calculate the body force
5. Calculate the resultant force

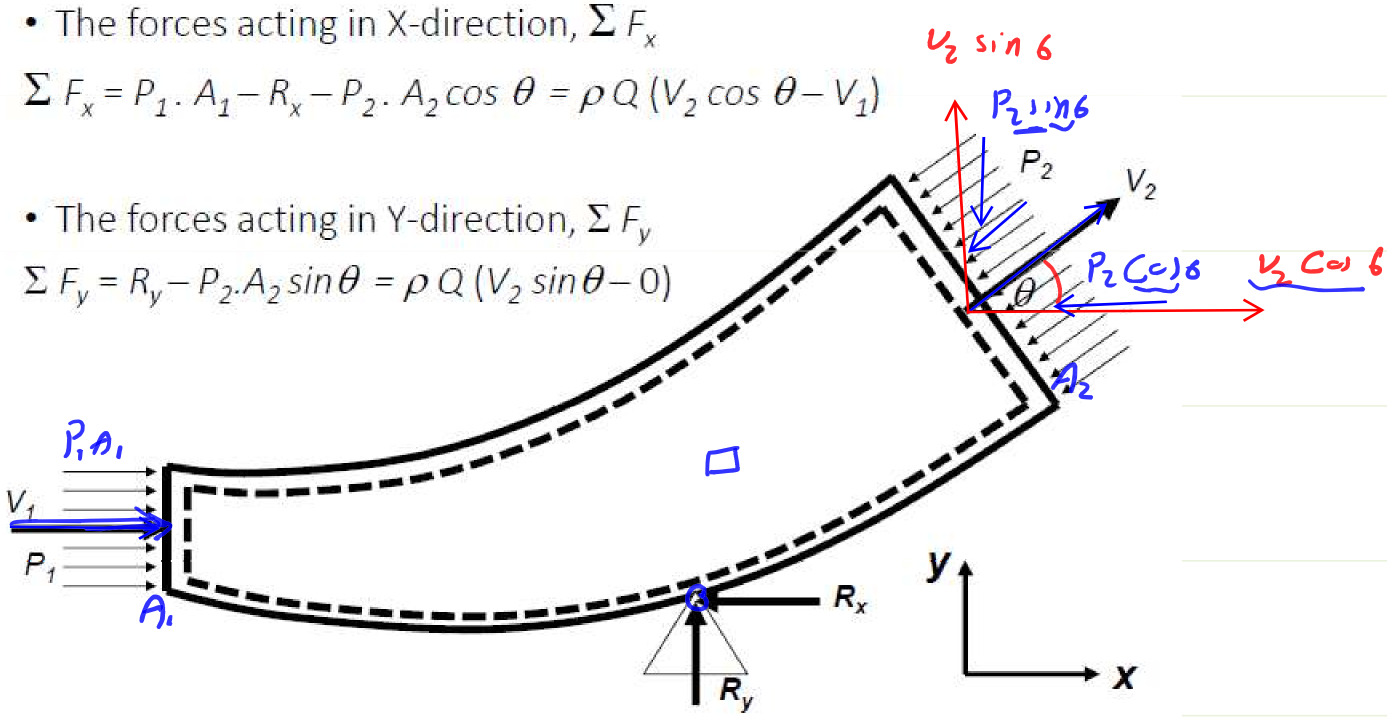
WRITING THE MOMENTUM EQUATION IN X, Y DIRECTIONS

- The forces acting in X-direction, ΣF_x

$\Sigma F_x = P_1 . A_1 - R_x - P_2 . A_2 \cos\theta = \rho Q (V_2 \cos\theta - V_1)$

- The forces acting in Y-direction, ΣF_y

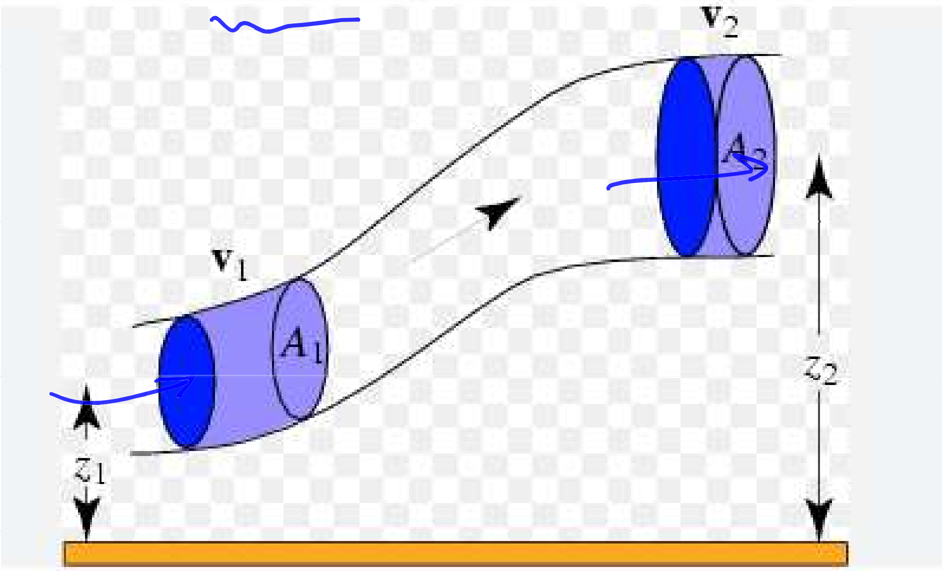
$\Sigma F_y = R_y - P_2 . A_2 \sin\theta = \rho Q (V_2 \sin\theta - 0)$



$\Sigma F_x = P_1 A_1 - R_x - P_2 A_2 \cos\theta = \dot{m} \beta (V_2 \cos\theta - V_1)$ *

$\Sigma F_y = R_y - P_2 A_2 \sin\theta = \dot{m} \beta (V_2 \sin\theta - 0)$ *

Bernoulli Equation



$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 \rightarrow *$$

ρg

EXAMPLE 1

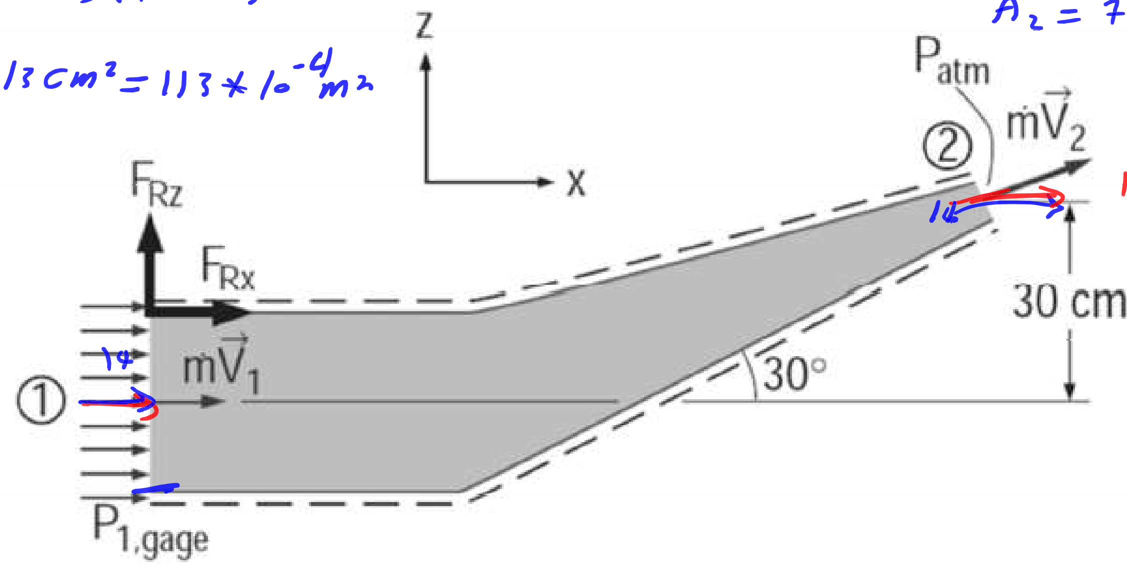
$\dot{m} = \rho \dot{V} = \rho A \cdot V$ $\dot{m} = 14\ kg/s$

A reducing elbow is used to deflect water flow at a rate of 14 kg/s in a horizontal pipe upward 30° while accelerating it and discharging it into the atmosphere. The area of the elbow is 113 cm² at the inlet and 7 cm² at the outlet. The elevation difference between the centers of the outlet and the inlet is 30 cm. The weight of the elbow and the water in it is considered to be negligible. Determine (a) the gage pressure at the center of the inlet of the elbow and (b) the anchoring force needed to hold the elbow in place. Assume the momentum correction factor $\beta = 1.03$.

$cm^2 \rightarrow (10^{-2} m)^2$

$A_2 = 7 \times 10^{-4} m^2$

$A_1 = 113\ cm^2 = 113 \times 10^{-4} m^2$



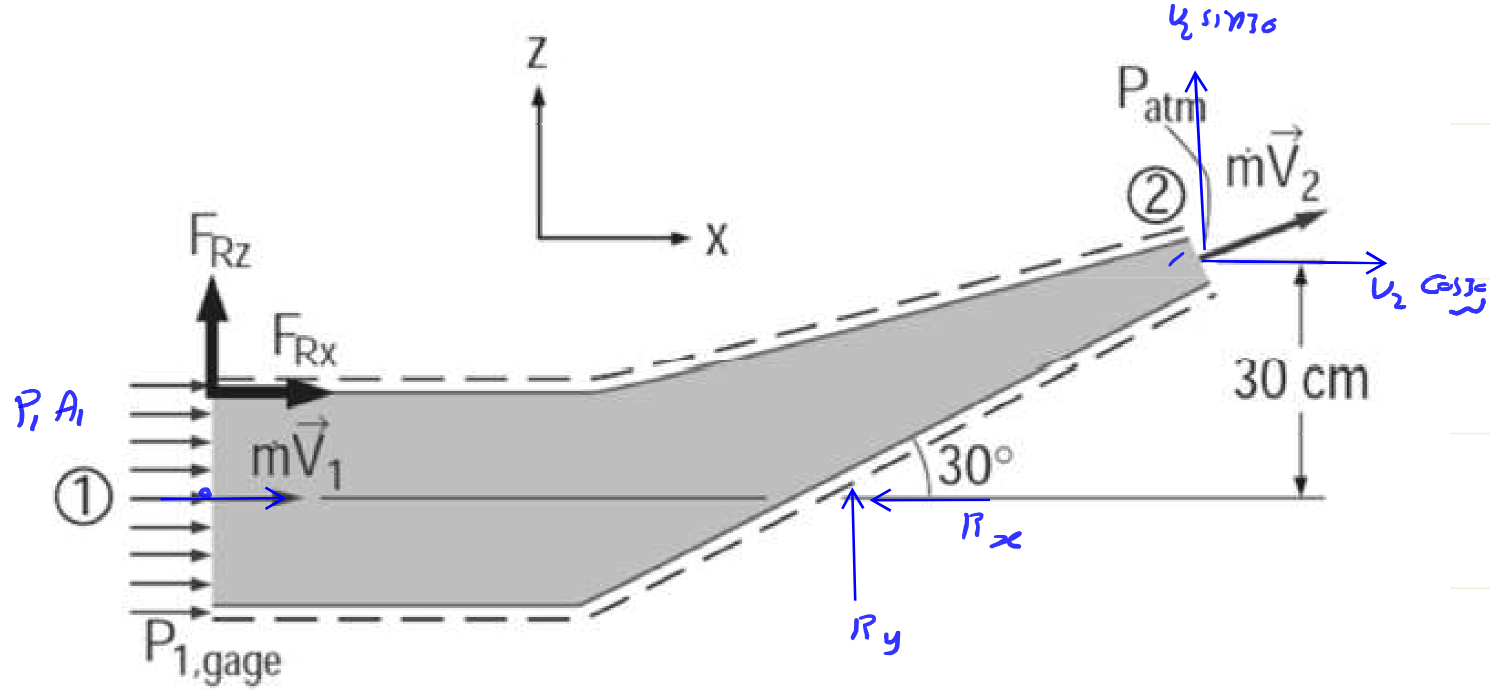
$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \quad 0.3$$

$$\dot{m} = \rho \dot{V} = \rho A V \Rightarrow V_1 = \frac{\dot{m}}{\rho A_1} = \frac{14}{1000 \times 113 \times 10^{-4}} = 1.24\ m/s$$

$$\Rightarrow V_2 = \frac{14}{1000 \times 7 \times 10^{-4}} = 20\ m/s$$

$$\frac{P_1}{1000 \times 9.81} + \frac{1.24^2}{2 \times 9.81} = \frac{20^2}{2 \times 9.81} + 0.3$$

$P_1 = 202.2\ kPA$



$$\Sigma F_x = P_1 A_1 - R_x = \dot{m}\beta (V_2 \cos 30 - V_1)$$

$$202.2 \times 10^3 \times 113 \times 10^{-4} - 14 \times 1.03 (20 \cos 30 - 1.24) = R_x$$

$$R_x = 2053 \, N$$

$$\Sigma F_z = R_z = \dot{m}\beta (V_2 \sin 30 - V_1)$$

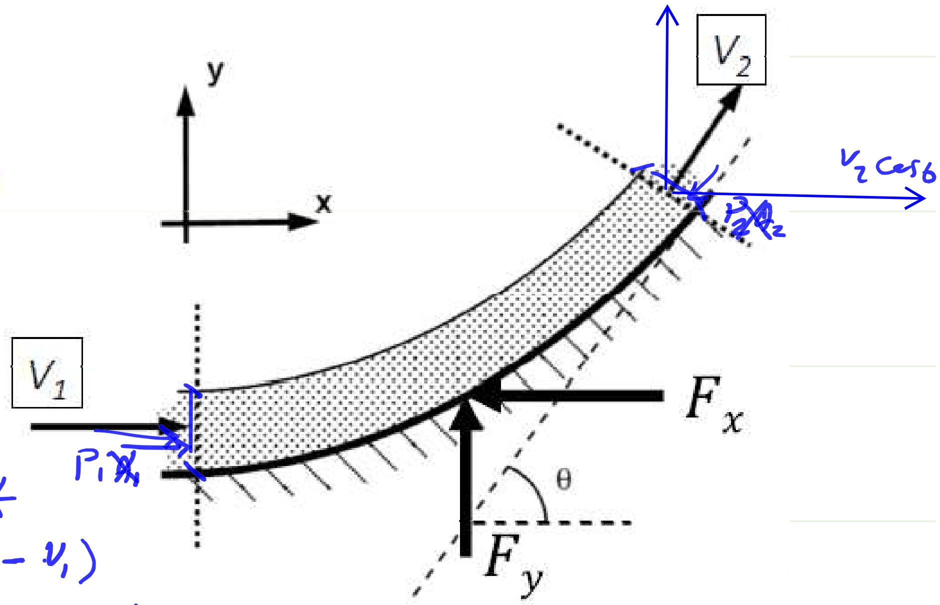
$$R_z = 14 \times 1.03 (20 \sin 30) = 144.2 \, N$$

$$R = \sqrt{2053^2 + 144.2^2} = 2058 \, N$$

$$\theta = \tan^{-1}\left(\frac{144.2}{2053}\right) = 4$$

FORCE ON A CURVED VANE

1 & 2 Control volume and Co-ordinate axis are as shown in the figure.



$$\Sigma F_x = \rho Q (V_2 \cos\theta - V_1)$$

From Continuity Eq.

$A_1 V_1 = A_2 V_2$ Q

Since $A_1 = A_2$

$V_1 = V_2$ $\Sigma F_x = -F_x$

$$-Fx = \rho Q V(\cos\theta - 1)$$ $= \dot{m}(V_2 \cos\theta - V_1)$

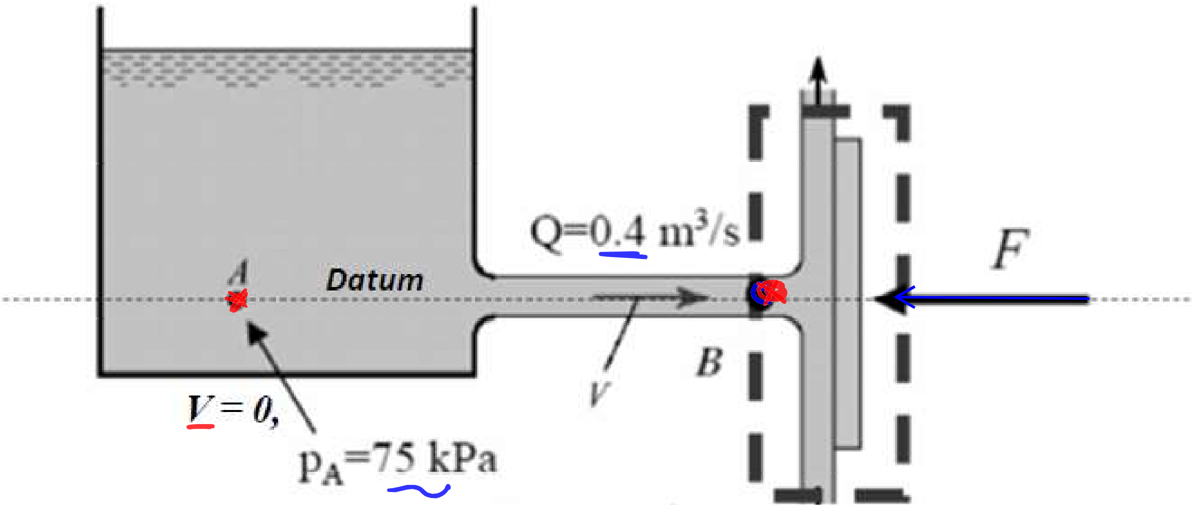
Similarly,

$$Fy = \rho Q V \sin\theta$$ $= \dot{m} V(\cos\theta - 1)$

This case is similar to that of a pipe, but the analysis is simpler. Pressures at ends are equal – atmospheric. Both the cross-section and velocities (in the direction of flow) remain constant.

EXAMPLE 2

Determine the force F needed to hold the plate in place ?



$$\Sigma F_x \Rightarrow R_x = F = \rho Q (V_2 - V_1) = \rho Q V_2$$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B$$

$$\frac{75000}{1000 * g} = \frac{V_B^2}{2g} \Rightarrow V_B = \sqrt{\frac{75000 * 2}{1000}} = 12.3 \; m/s$$

$$F = R_x = 1000 * 0.4 * 12.3 = 4.9 \; kN$$