Problem Set 4:
Fluids in motion – Part 2

Due Date: 30 April 2010

SESG1005
Fluid Mechanics

Name:

ID:

Cohort: ☐ Aero ☐ Mech ☐ Ship

Q.1 A vertical, 1cm-diameter jet of water impinges upon a bathroom scale such that the latter exhibits a reading of 5kg. Estimate the volume flow rate of the jet.

Solution:

Solution Feedback*:

☐ *Complete* (critical assumptions stated, relevant diagrams included, full and correct working shown, and correct answer [including units])

☐ *Logical* (moving from general to specific, with each step justified by previous ones, with appropriate "narrative")

Mark (Completeness and Logic):

☐ 3/3 – All criteria fully met

☐ 2/3 – Minor error(s), as indicated

☐ 1/3 – Some merit

☐ 0/3 – No credit

☐ *Professionally presented* ("clean", legible, attractive)

(continue solution on back of page if necessary)

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Q.2 A single-propeller aircraft flies horizontally at 100mph. If the overall drag coefficient C_D and cross-sectional (projected) area A of the entire aircraft are respectively 0.45 and 3.25m^2, and the propeller diameter d = 2m, compute the speed of the air passing through the propeller, with respect to an appropriate reference frame. Clearly state all assumptions.

Solution:

Solution Feedback*:

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Q.3 Calculate the total flux of horizontal momentum per unit area passing through vertical planes far downstream of the aircraft described in Question 2. Consider a reference frame attached to the aircraft, and express your answer in terms of the deviation from conditions far upstream of the aircraft.

Solution:

Solution Feedback*:

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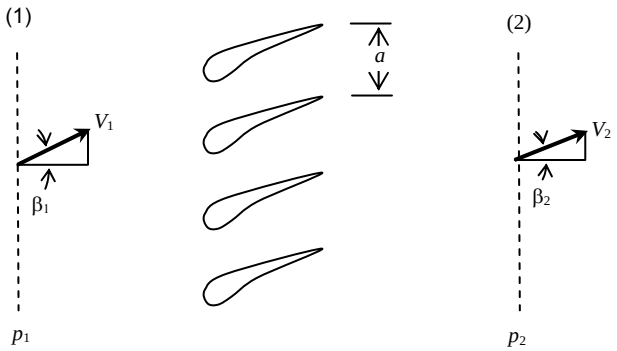
Q.4 An incompressible fluid of density ρ flows steadily through a two-dimensional infinite row of fixed vanes, a few of which are shown below. The vane spacing is a. The velocities V_1 and V_2 and pressures p_1 and p_2 are all constant along their respective stations, (1) and (2). The directions of the two velocities are given by the angles β_1 and β_2, as shown. Find the horizontal and vertical components of the force necessary to keep one vane in place. Express your answer in terms of ρ, a, p_1, p_2, V_1, β_1 and β_2.

Solution:



Solution Feedback*:

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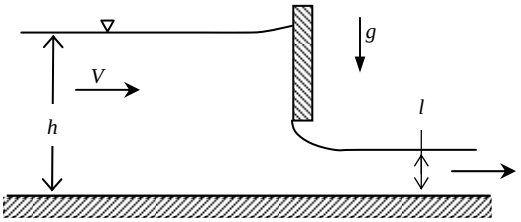
Q.5 An incompressible, inviscid liquid of density ρ flows, under the influence of gravity, beneath the sluice gate shown. The height and velocity upstream of the gate are h and V, respectively, while downstream of the gate the height is l. Show that the force per unit width necessary to hold the gate in place is given by $\rho g(h\text{-}l)^3/[2(h+l)]$.

Solution:



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