國立成功大學

113學年度碩士班招生考試試題

編　號：134

系　所：航空太空工程學系

科　目：流體力學

日　期：0201

節　次：第 2 節

備　註：不可使用計算機

編號： 134

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※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

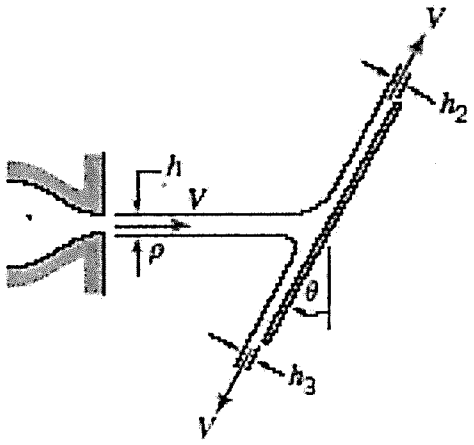
1. Consider the flow field given by stream function $\Psi = ax^2 - ay^2$, where $a = 3\ s^{-1}$. Show that the flow is irrotational. Determine the velocity potential for this flow. (20%)

2. A two-dimensional steady flow in a **viscous** liquid is described by the equation:

$$u\frac{\partial u}{\partial x} = -g\frac{\partial h}{\partial x} + \frac{\mu}{\rho}\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right)$$

Use a length scale, L, and a velocity scale, V_0, to nondimensionalize this equation. Obtain the dimensionless groups that characterize this flow. (20%)

3. When a plane liquid jet strikes an inclined flat plate, it splits into two streams of equal speed but unequal thickness. For frictionless flow there can be no tangential force on the plate surface. Use this assumption to develop an expression for h_2/h as a function of plate angle, θ. Plot your results and comment on the limiting cases, $\theta = 0°$ and $\theta = 90°$. (10%)



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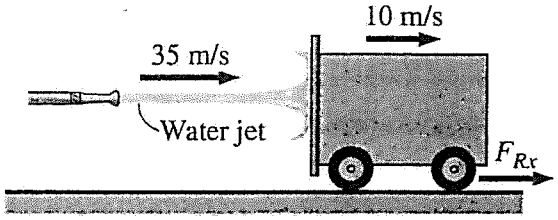
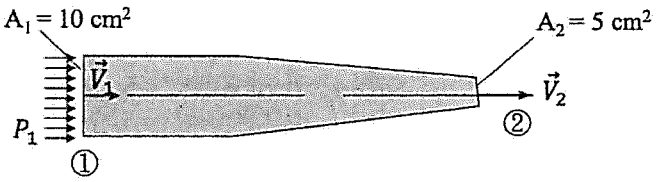
EX 4 **(15 pts)**

Water accelerated by a nozzle to 35 m/s strikes the vertical back surface of a cart moving horizontally at a constant velocity of 10 m/s in the flow direction (see figure) The mass flow rate of water through the stationary nozzle is 30 kg/s. After the strike, the water stream splatters off in all directions in the plane of the back surface. (a) Determine the force that needs to be applied by the brakes of the cart to prevent it from accelerating. (b) If the mass of the cart is 400 kg and the brakes fail, determine the acceleration of the cart when the water first strikes it. Assume the mass of water that wets the back surface is negligible.



EX 5 **(15 pts)**

In a straight tube filled with water (as shown in figure), at the inlet the pressure is 2 atm, and the flow velocity is 10 m/s. Calculate velocity and pressure at the exit knowing that the inlet area is 10 cm^2 and the exit area is 5 cm^2.



Consider:

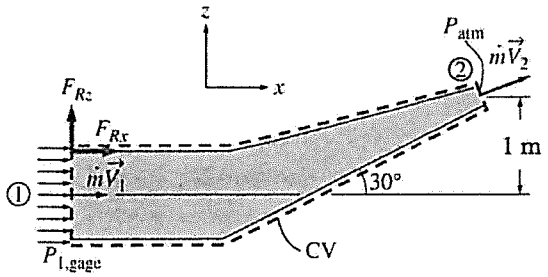
Flow uniform over areas

1 atm ≃ 10^5 Pa

Water density ≃ 1000 kg/m^3

EX 6 **(20 pts)**

A reducing elbow is used to deflect water flow at a rate of 10 kg/s in a horizontal pipe upward 30° while accelerating it (see figure). The elbow discharges water into the atmosphere. The cross-sectional area of the elbow is 10 cm^2 at the inlet and 5 cm^2 at the outlet. The elevation difference between the centers of the outlet and the inlet is 1 m. The weight of the elbow and the water in it is considered to be negligible.



Determine (a) the pressure at the inlet and (b) the anchoring force needed to hold the elbow in place.

Consider:

Cos(30 deg) ≃0.86, sin(30 deg) = 0.5

Flow uniform over areas

1 atm ≃ 10^5 Pa

Water density ≃ 1000 kg/m^3

Gravity = 9.81m/s^2 ≃ 10 m/s^2