編號： 136

國立成功大學 108 學年度碩士班招生考試試題

系　　所：航空太空工程學系

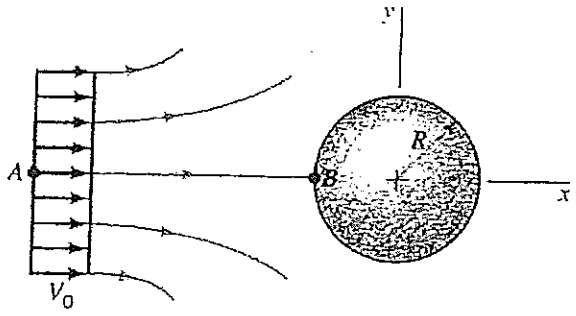
考試科目：流體力學

考試日期：0223，節次：2

※ 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。

Prob. 1

An incompressible, inviscid fluid flows a steadily past a sphere of radius R, as shown in figure below. Velocity along a streamline from point A at x=-∞ to the stagnation point B at x=-R is given by $\vec{V}=u(x)\vec{i}=V_0(1+R^2/x^2)\vec{i}$, where V_0 is the upstream velocity far ahead of the sphere.

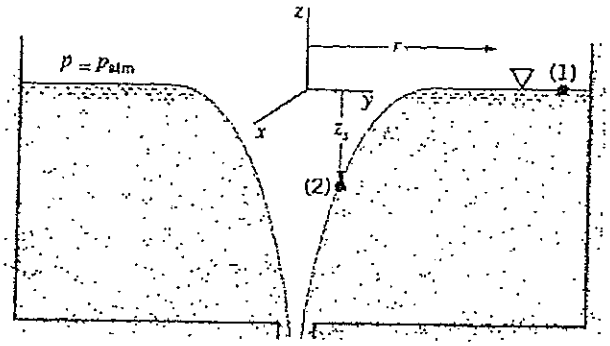


(a) Determine the acceleration in x-direction a_x experienced by fluid particles as they flow along this streamline. (10%)

(b) Find the maximum deceleration and its location. (note: do not need to calculate the exact number) (10%)

Prob. 2

A liquid drains from a large tank through a small opening as illustrated in the figure below. A vortex forms whose velocity distribution away from the tank opening can be approximated as that of a free vortex having a stream function $\psi = -\frac{\Gamma}{2\pi}\ln r$ where Γ is the circulation of the free vortex. Determine a expression relating the surface shape $z_s(r)$ to the strength of the vortex specified by the circulation Γ. (10%)



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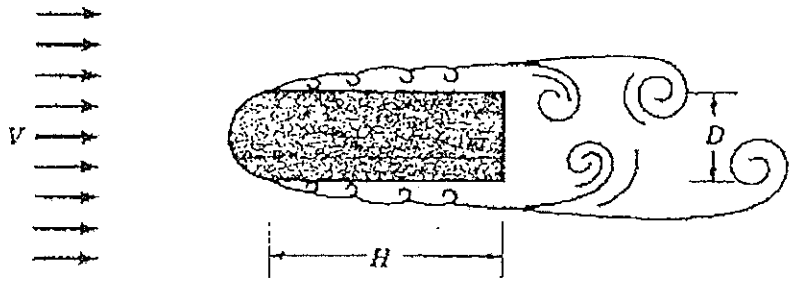
Prob. 3

A long structural component of a bridge has the cross section shown in figure below. It is known that when a steady wind blows past this type of bluff body, vorticities may develop on the downwind side that are shed in a regular fashion at some definite frequency. Since these vortices can create harmful periodic forces acting on the structure. It is important to determine the shedding frequency. For the specific prototype structure of interest, D=0.1m, H=0.3m, and a representative wind velocity is 50km/hr. Standard air can be assumed. The shedding frequency is to be determined through the use of a small-scale model that is to be tested in a water tunnel. For the model D_m=20mm and the water temperature is 20°C.

Hint: For air at standard conditions, viscosity $\mu=1.79\times10^{-5}$ kg/m·s, density $\rho=1.23$ kg/m^3, and for water at 20°C, viscosity $\mu=1.00\times10^{-3}$ kg/m·s, density $\rho=998$ kg/m^3



(a) Determine the model dimension, H_m, and the velocity at which the test should be performed. (10%)

(b) If the shedding frequency for the model is found to be 50Hz, what is the corresponding frequency for the prototype? (10%)

Prob. 4

What is the definition of Reynolds Number, and what is the physical meaning of it? (10%)

Prob. 5

Water is discharged from a 20cm diameter pipe at the bottom of a tank with a water level of 30m. Calculate the mass flow rate of the water at the discharge. (20%)

Prob. 6

A car is moving in the air at speed 120 ft/s with drag coefficient 0.4. The front view sectional area is 20 square ft. The air density is 0.00238 slug/cubic ft.

1) calculate the aerodynamic drag force acting on the car (10%)

2) calculate the power (unit: horse power or KW) required to move the car at the above speed (neglecting the tire frictional force). (10%)