編號： 136

國立成功大學 109 學年度碩士班招生考試試題

系　　所：航空太空工程學系

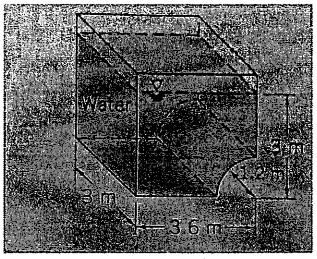
考試科目：流體力學

考試日期：0210，節次：2

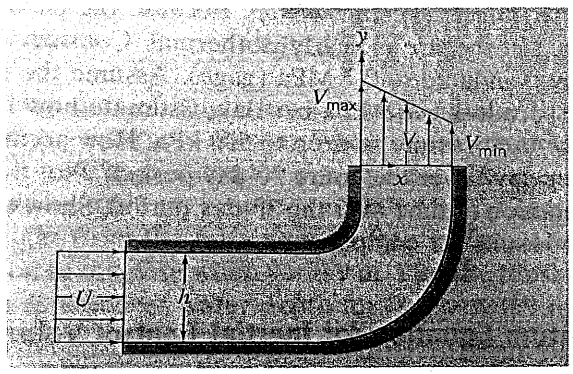
※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A velocity field given by $\vec{V} = aytî - bxĵ$, where a=1 s^{-1} and b=4 s^{-1}. Find the equation of the streamlines at any time t. Plot several streamlines at t=0 s, t=1 s, and t=20 s. (10 points)

2. An open tank is filled with water to the depth indicated. Atmospheric pressure acts on all outer surfaces of the tank. Determine the magnitude and line of action the vertical component of the force of the water on the curved part of the tank bottom. (20 points)

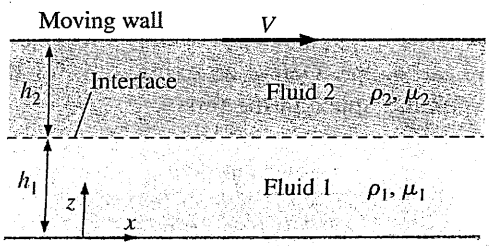


3. Water enters a two-dimensional, square channel of constant width, h=75.5 mm with uniform velocity, U. The channel makes a 90° bend that distorts the flow to produce the linear velocity profile shown at the exit, with $v_{max} = 2v_{min}$. Evaluate v_{min}, if U=7.5 m/s. (20 points)



4. Please show the time rate of change of the velocity the observer see for the river in following situation: (15 points)
   (a) An observer is standing on a boat which is tied to the river bank. The river is flowing at the velocity $\mathbf{V}=u\hat{i}+v\hat{j}$
   (b) An observer is standing on a boat which travels with a velocity $\mathbf{V}_b=u_b\hat{i}+v_b\hat{j}$ across a river flowing at the velocity $\mathbf{V}=u\hat{i}+v\hat{j}$
   (c) An observer is standing on a boat which drifts with a river flowing at the velocity $\mathbf{V}=u\hat{i}+v\hat{j}$

5. Consider a modified form of Couette flow in which there are two immiscible fluids sandwiched between two infinitely long and wide, parallel flat plates. The flow is steady, incompressible, parallel, and laminar. The top plate moves at velocity V to the right, and the bottom plate is stationary. Gravity acts in the $-z$ direction (downward in the figure). There is no forced pressure gradient pushing the fluids through the channel. You could ignore the surface tension effect and assume the interface between two fluids is horizontal. The pressure at the bottom of the flow is equal to P_0. (20 points)
   (a) Please find the expression of the velocity field. (Hint: Split up the solution into two portions, one for each fluid.)
   (b) Please find the expression of the pressure field. (Hint: Again, split up the solution.)



6. A 1/9 scaled model of a tractor-trailer rig is test in a wind tunnel. The model frontal area is 0.2 m^2. When test at $V_m = 100\ ms^{-1}$ in the air which density is 1.2 kg/m^3, the measured drag force is $F_D = 400\ N$.

   Please evaluate the drag coefficient for the model conditions given. Assuming that the drag coefficient is the same for model and prototype, calculate the drag force on a prototype rig at a highway speed of 120 km/h. Determine the air speed at which a model should be tested to ensure dynamically similar results if the properties of the air didn't change in the wind tunnel. Is this air speed practical? Why or why not? (15 points)