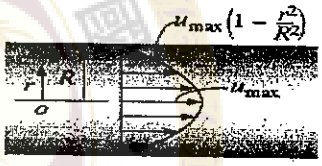
每題２０分　共五題

請依題號次序作答

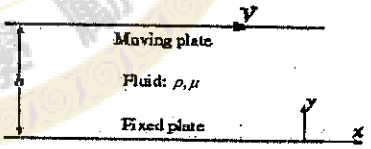
1. **The equation for an unsteady, two-dimensional velocity field that is linear in both spatial directions (*x* and *y*) is $\vec{V} = (\sin t + a_1 x + b_1 y)\vec{i} + (a_2 x + b_2 y)\vec{j}$. What is the acceleration field $\vec{a}(x, y, t)$.**

2. **Consider a steady, two-dimensional, incompressible velocity field with $u = ax + b$; $v = -ay + cx$. where $a = 5.0\ s^{-1}, b = 15$ m/s, *and* $c = 5.0\ s^{-1}$.**
   (1) Find the stream function, $\psi(x, y)$, of this field.
   (2) Calculate the flow rate (m^2/s) between two streamlines which pass through the points (0,0) and (2,5) respectively.

3. **In regions far from the entrance, fluid flow through a circular pipe is one-dimensional, and the velocity profile for laminar flow is given by $u = u_{max}(1 - \frac{r^2}{R^2})$, where *R* is the radius of the pipe, *r* is the radial distance from the center of the pipe, and u_{max} is the maximum flow velocity, which occurs at the center.**
   (*a*) Derive the relation for the drag force applied by the fluid on a section of the pipe of length L.
   (b) Calculate the drag force for water flow at 20°C with $R = 0.08\ m$, $L = 20\ m$, $u_{max} = 4\ m/s$ and $\mu = 0.001 kg/m \cdot s$

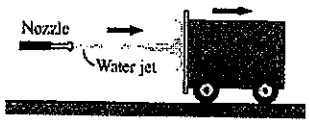


4. **Consider steady, incompressible, laminar flow of a Newtonian fluid in the narrow gap between two infinite parallel plates. The top plate is moving at speed *V*, and the bottom plate is stationary. The distance between these two plates is *h*. If the pressure gradient, $\partial p/\partial x$, in x-direction is constant, and ignore the gravity effect.**
   (1) Find the velocity profile between these two plates.
   (2) What is the shear stress acting on the bottom plate.
   when $\frac{\partial p}{\partial x} = \frac{2\mu V}{h^2}$



   Hint : Navier-Stokes Equation: $\rho \frac{D\vec{V}}{Dt} = -\nabla p + \rho \vec{g} + \mu \nabla^2 \vec{V}$

5. **A constant velocity horizontal water jet from a stationary nozzle impinges normally on a vertical flat plate that is held in frictionless track. As the water jet hits the plate, it begins to move due to the water force. If the absolute velocity of the jet is, $V_j = 10 m/s$. The mass of the cart is, $m_c = 50 kg$. The sectional area of the stationary nozzle is, $A = 10^{-2} m^2$. The density of the water is, $\rho = 1000 kg/m^3$. When the cart is started from rest, What is the absolute velocity of the cart. $V = V(t)$? Compute $V(t)$ at $t = 0.8$s.**



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