(1) (20) Given a velocity field $\vec{V} = (u, v) = (1+x)\vec{i} + (1+\sin t - y)\vec{j}$

(a) (2) Is the flow steady or unsteady, why?

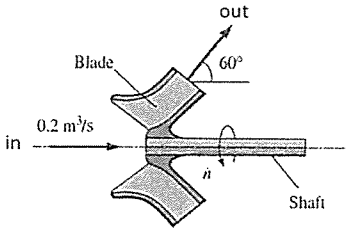
(b) (3) Is the flow compressible or incompressible, why?

(c) (3) Is the flow rotational or irrotational, why?

(d) (12) Find the x coordinate of a particle starting at (x(0), y(0))=(0, 0)

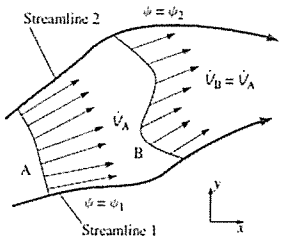
(2) (20) A 1.2-m-diameter, 3-m-high sealed vertical cylinder is completely filled with gasoline whose density is 740 kg/m3. The tank is now rotated about its vertical axis at a rate of 70 rpm. Determine the difference between the pressures at the center of the top surface and the edge of the bottom surface. Hint: Treat the fluid in solid-body motion and satisfy the equation of motion, $\frac{\partial P}{\partial r} = \rho r\omega^2$, $\frac{\partial P}{\partial r} = 0$ *and* $\frac{\partial P}{\partial r} = -\rho g$

(3) (20) Water enters a mixed flow pump axially at a rate of 0.2 $m^3/s$ and at a velocity of 5 m/s, and is discharged to the atmosphere at an angle of 60° from the horizontal. If the discharge flow area is half the inlet area, determine the force acting on the shaft in the axial direction.




(4) (20) Given $u = \frac{\partial \Psi}{\partial y}$ *and* $v = -\frac{\partial \Psi}{\partial x}$

Show the difference in the value of ψ (stream function) from one streamline to another is equal to the volume flow rate per unit width between the two streamlines.




(5) (20) Navier-Stokes Equation, $\rho\frac{D\vec{V}}{Dt} = -\nabla p + \rho\vec{g} + \mu\nabla^2\vec{V}$, where $\vec{V} = (u, v, w)$ in a Cartesian coordinate system and gravity acts in negative z direction.

(a) (5) write down the component equation in y direction.

(b) (15) nondimensionalize the equation in (a) with $(x, y, z) = L(x^*, y^*, z^*)$, $t = Tt^*$, $\vec{V} = \frac{L}{T}\vec{V}^*$ and $p = (\rho\frac{L^2}{T^2})p^*$, where parameters with * denote dimensionless parameters.

試題隨卷繳回