KOELJ SAINS DAN TEKNOLOGI
TUTORIAL POTENTIAL FLOW

DDJ 3303

6.5 Determine an expression for the vorticity of the flow field described by

$$\mathbf{V} = -xy^3\,\hat{\mathbf{i}} + y^4\hat{\mathbf{j}}$$

Is the flow irrotational?

6.7 For a certain incompressible, two-dimensional flow field the velocity component in the y direction is given by the equation

$$v = 3xy - x^2y$$

Determine the velocity component in the x direction so that the continuity equation is satisfied.

6.10 For a certain incompressible flow field it is suggested that the velocity components are given by the equations

$$u = 2xy \qquad v = -x^2y \qquad w = 0$$

Is this a physically possible flow field? Explain.

6.11 The velocity components of an incompressible, two-dimensional velocity field are given by the equations

$$u = y^2 - x(1 + x)$$
$$v = y(2x + 1)$$

Show that the flow is irrotational and satisfies conservation of mass.

6.12 For each of the following stream functions, with units of m^2/s, determine the magnitude and the angle the velocity vector makes with the x-axis at $x = 1$ m, $y = 2$ m. Locate any stagnation points in the flow field.
(a) $\psi = xy$
(b) $\psi = -2x^2 + y$

6.13 The stream function for an incompressible, two-dimensional flow field is

$$\psi = ay - by^3$$

where a and b are constants. Is this an irrotational flow? Explain.

6.15 The velocity components for an incompressible, plane flow are

$$v_r = Ar^{-1} + Br^{-2} \cos \theta$$

$$v_\theta = Br^{-2} \sin \theta$$

where A and B are constants. Determine the corresponding stream function.

6.28 The stream function for a given two-dimensional flow field is

$$\psi = 5x^2y - (5/3)y^3$$

Determine the corresponding velocity potential.

6.29 Determine the stream function corresponding to the velocity potential

$$\phi = x^3 - 3xy^2$$

Sketch the streamline $\psi = 0$, which passes through the origin.

6.32 The velocity potential for a certain inviscid flow field is

$$\phi = -(3x^2y - y^3)$$

where ϕ has the units of ft^2/s when x and y are in feet. Determine the pressure difference (in psi) between the points (1, 2) and (4, 4), where the coordinates are in feet, if the fluid is water and elevation changes are negligible.

6.63 The velocity potential for a cylinder (Fig. P6.63) rotating in a uniform stream of fluid is

$$\phi = Ur\left(1 + \frac{a^2}{r^2}\right) \cos \theta + \frac{\Gamma}{2\pi} \theta$$

where Γ is the circulation. For what value of the circulation will the stagnation point be located at: **(a)** point A, **(b)** point B?

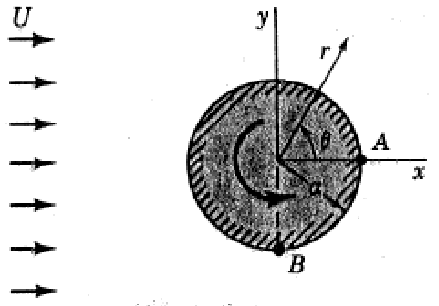

FIGURE P6.63