6.38

6.38 The streamlines for an incompressible, inviscid, two-dimensional flow field are all concentric circles and the velocity varies directly with the distance from the common center of the streamlines; that is

$$v_\theta = Kr$$

where K is a constant. **(a)** For this *rotational* flow determine, if possible, the stream function. **(b)** Can the pressure difference between the origin and any other point be determined from the Bernoulli equation? Explain.

(a) $$v_\theta = -\frac{\partial \psi}{\partial r} = Kr \qquad (1)$$

Integrate Eq. (1) with respect to r to obtain

$$\int d\psi = -\int Kr\, dr$$

or

$$\psi = -\frac{Kr^2}{2} + f_1(\theta)$$

Since $$v_r = \frac{1}{r}\frac{\partial \psi}{\partial \theta} = 0$$

it follows that ψ is not a function of θ and therefore

$$\underline{\underline{\psi = -\frac{Kr^2}{2} + C}}$$

where C is an arbitrary constant.

(b) The flow is rotational and therefore the Bernoulli equation cannot be applied between the origin and any point, since these points are not on the same streamline. <u>No.</u>

(Refer to discussion associated with derivation of Eq. 6.57.)