Problem 5.8

Given: The y component of velocity for a steady, incompressible flow in the xy plane is

$v = Ay^2/x^2$, where $A = 2\ m/s$, x and y in m

Find: simplest x component.

Solution: Apply differential form of conservation of mass

For two-dimensional, incompressible flow,

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \quad \text{Thus} \quad \frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y} = -A\frac{y^2}{x^2}$$

Integrating,

$$u = \frac{2Ay}{x} + f(y)$$

The simplest form is for $f(y) = 0$

Thus,

$$u = 2\frac{Ay}{x} = 4\frac{y}{x} \longrightarrow u$$

and

$$\vec{V} = 2A\frac{y}{x}\hat{i} + A\frac{y^2}{x^2}\hat{j} = 4\frac{y}{x}\hat{i} + 2\frac{y^2}{x^2}\hat{j} \longrightarrow \vec{V}$$