

Problem 2.4

[Difficulty: 1]

2.4 For the velocity field $\vec{V} = Ax^2y\hat{i} + Bxy^2\hat{j}$, where $A = 2 \text{ m}^{-2}\text{s}^{-1}$ and $B = 1 \text{ m}^{-2}\text{s}^{-1}$, and the coordinates are measured in meters, obtain an equation for the flow streamlines. Plot several streamlines in the first quadrant.

Given: Velocity field

Find: Equation for streamlines

Solution:

For streamlines

$$\frac{v}{u} = \frac{dy}{dx} = \frac{B \cdot x \cdot y^2}{A \cdot x^2 \cdot y} = \frac{B \cdot y}{A \cdot x}$$

So, separating variables

$$\frac{dy}{y} = \frac{B}{A} \cdot \frac{dx}{x}$$

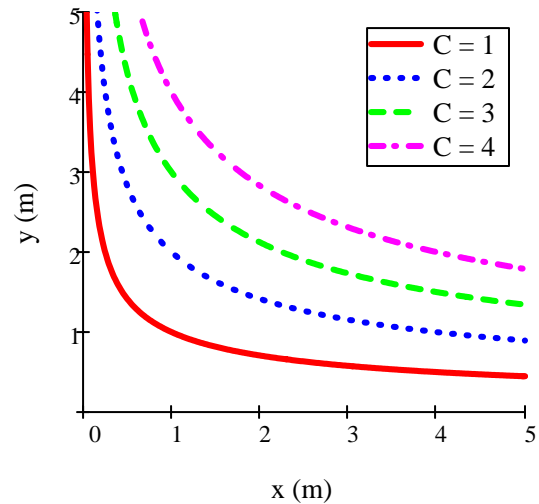
Integrating

$$\ln(y) = \frac{B}{A} \cdot \ln(x) + c = -\frac{1}{2} \cdot \ln(x) + c$$

The solution is

$$y = \frac{C}{\sqrt{x}}$$

Streamline Plots



The plot can be easily done in *Excel*.