

Problem 2.5

[Difficulty: 2]

2.5 The velocity field $\vec{V} = Ax\hat{i} - Ay\hat{j}$, where $A = 2 \text{ s}^{-1}$, can be interpreted to represent flow in a corner. Find an equation for the flow streamlines. Explain the relevance of A . Plot several streamlines in the first quadrant, including the one that passes through the point $(x, y) = (0, 0)$.

Given: Velocity field

Find: Equation for streamlines; Plot several in the first quadrant, including one that passes through point $(0,0)$

Solution:

Governing equation: For streamlines $\frac{v}{u} = \frac{dy}{dx}$

Assumption: 2D flow

Hence $\frac{v}{u} = \frac{dy}{dx} = -\frac{A \cdot y}{A \cdot x} = -\frac{y}{x}$

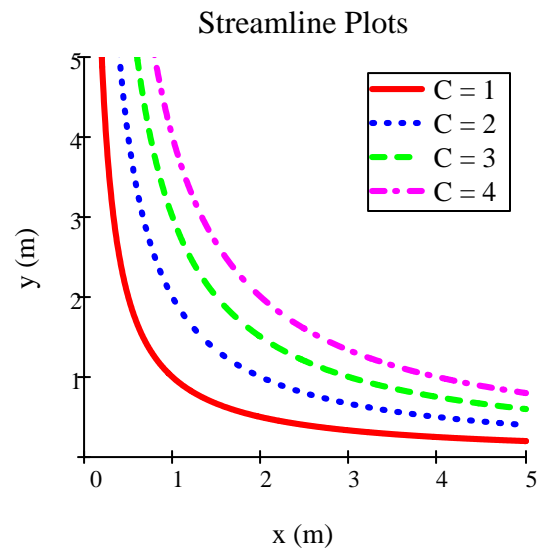
So, separating variables $\frac{dy}{y} = -\frac{dx}{x}$

Integrating $\ln(y) = -\ln(x) + c$

The solution is $\ln(x \cdot y) = c$

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

The plot can be easily done in *Excel*.



The streamline passing through $(0,0)$ is given by the vertical axis, then the horizontal axis.

The value of A is irrelevant to streamline shapes but IS relevant for computing the velocity at each point.