# Problem sheet II



## 1. Streamlines

Sketch the streamline pattern (see page 19 for the definition) for the following three flow examples. The velocity components in the three referenced orthogonal dirctions are given by:

(a) $(-ax, ay, 0)$ in Cartesian Coordinates

(b) $(m/r, 0, 0)$ in Cylindrical Polar Coordinates

(c) $(0, k/r, 0)$ in Cylindrical Polar Coordinates

## 2. Vorticity and Divergence

Calculate the values of the vorticity and divergence of the three flow fields prescribed in the above question. For (b) and (c) distinguish between $r \neq 0$ and $r = 0$.

## 3. Divergence, Deformation and Vorticity

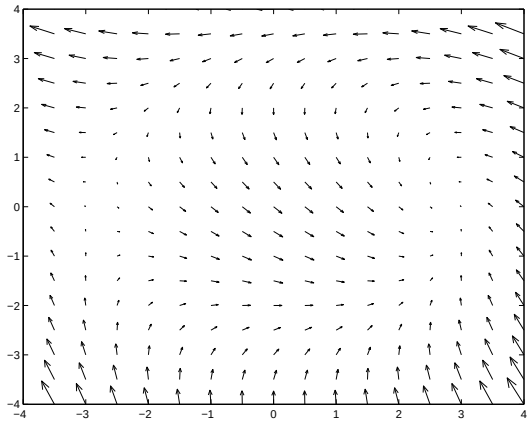
A two-dimensional flow field is defined in Cartesian Coordinates by:

$$u = -\left(x^2 + (y+a)^2 - r^2\right)$$
$$v = \left(x^2 + (y-a)^2 - r^2\right)$$

Here $r$ and $a$ are constants with $(r^2 > a^2)$ and the corresponding streamline field is shown below.

(a) Indicate where you anticipate the regions of large divergence, deformation and vorticity.

(b) Plot the flow field $(u, v)$ and the solutions from (a) using a programm like *Maple, Mathematica, Matlab.*




x,y-axis = (-4,4), $r$=3, $a$=1

## 4. Divergence

If a fluid parcel experiences a 10% change in density in two hours, what value of divergence does it undergo? Indicate what happens if the density change is +10% or -10%.