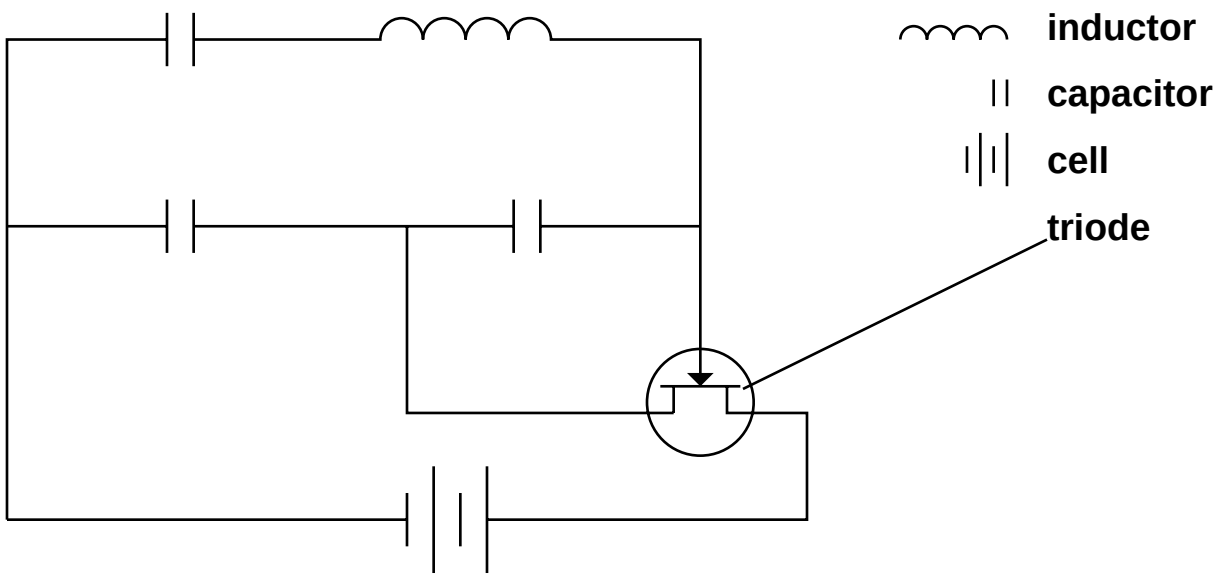
The current in a triode oscillator varies periodically.
For example, the Clapp Oscillator:



The current in such a circuit can be described by the van der Pol equation:

$$\frac{d^2u}{dt^2} - k(1-u^2)\frac{du}{dt} + u = 0$$

where u is current, t is time, and k is a positive constant.

if we let x = u and $\frac{dx}{dt} = y$

then the system becomes

$$\frac{dx}{dt} = y \qquad \frac{dy}{dt} = -x + k(1 - x^2)y$$

close to the origin, the van der Pol equation can be approximated

by the linear system

$$\frac{d}{dt}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & k \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix}$$

which has one critical point at (0,0). It is an unstable spiral point.

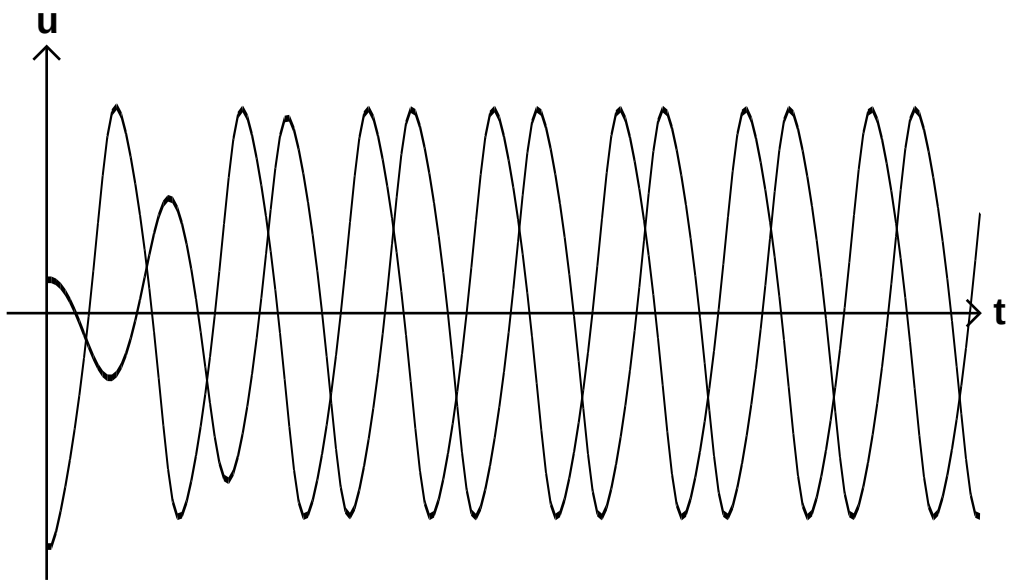
Away from the origin, it can't be approximated by a linear system.
The $1-u^2$ must be taken into account, and all three terms of the equation

$$\frac{d^2u}{dt^2} - k(1-u^2)\frac{du}{dt} + u = 0$$

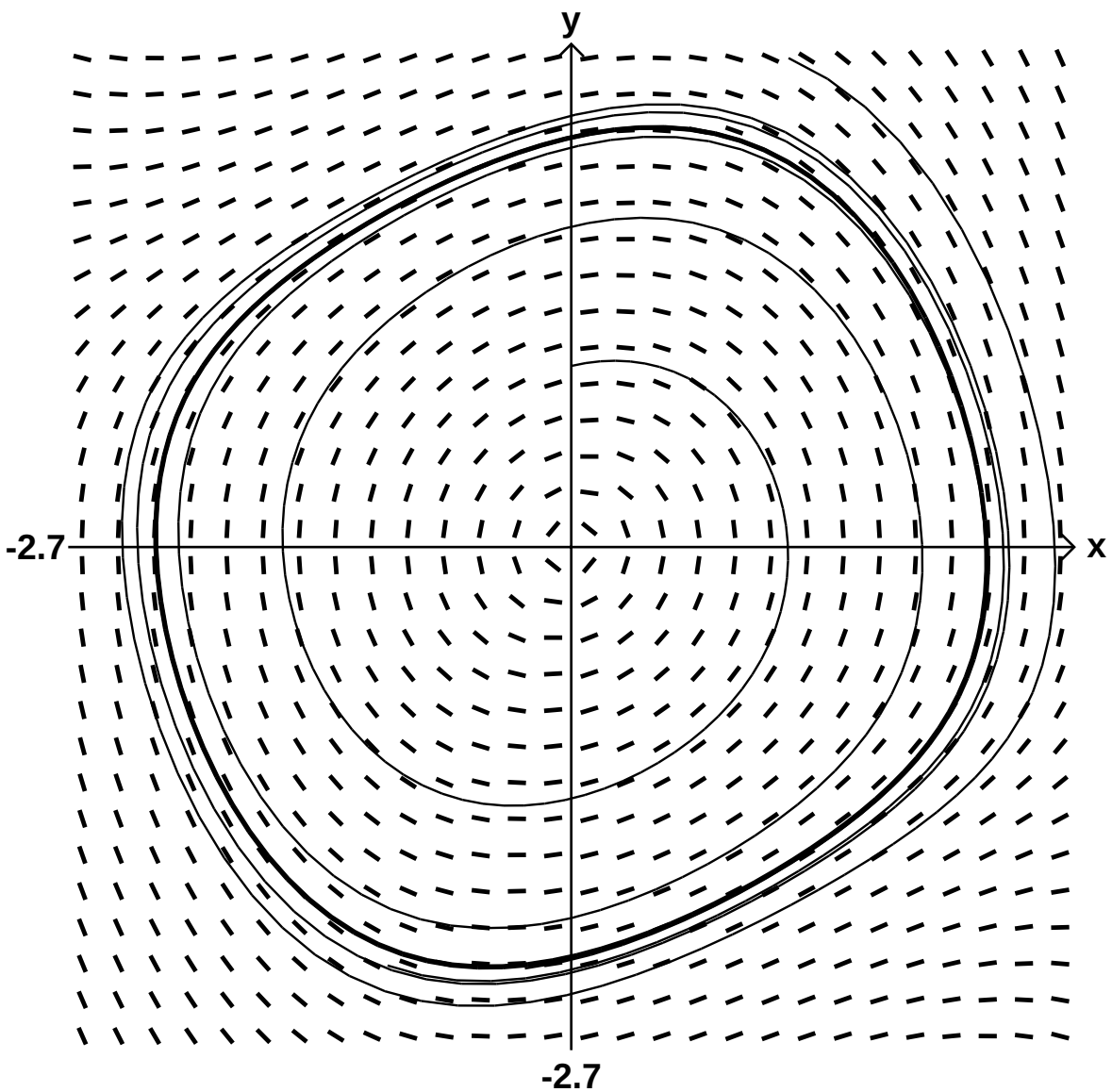
are positive. Similar to an Euler equation with all positive terms,
the solutions are decreasing over time.

Close to the origin the solutions are increasing, and away from the
origin the solutions are decreasing.

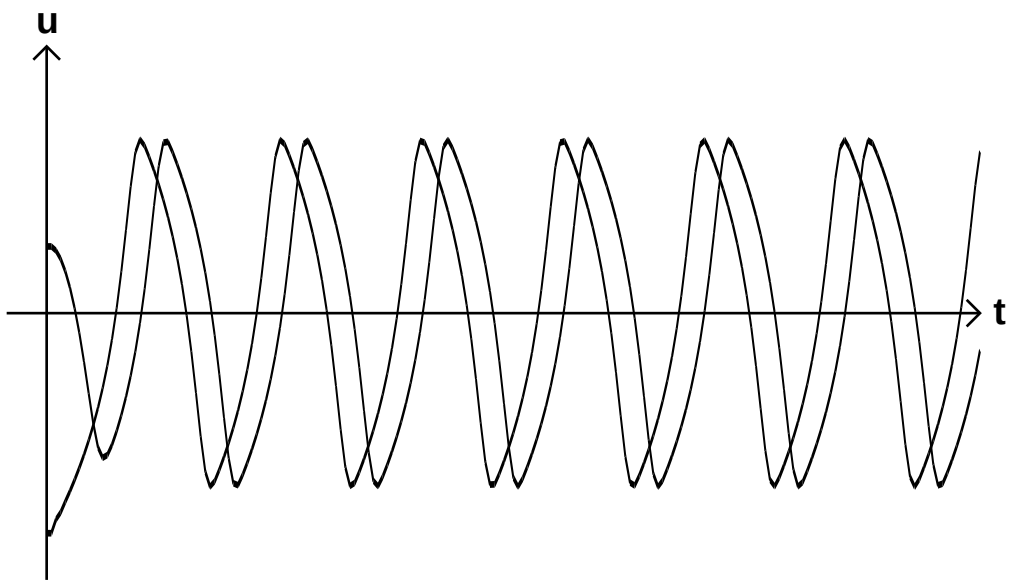
u vs t for k=0.2



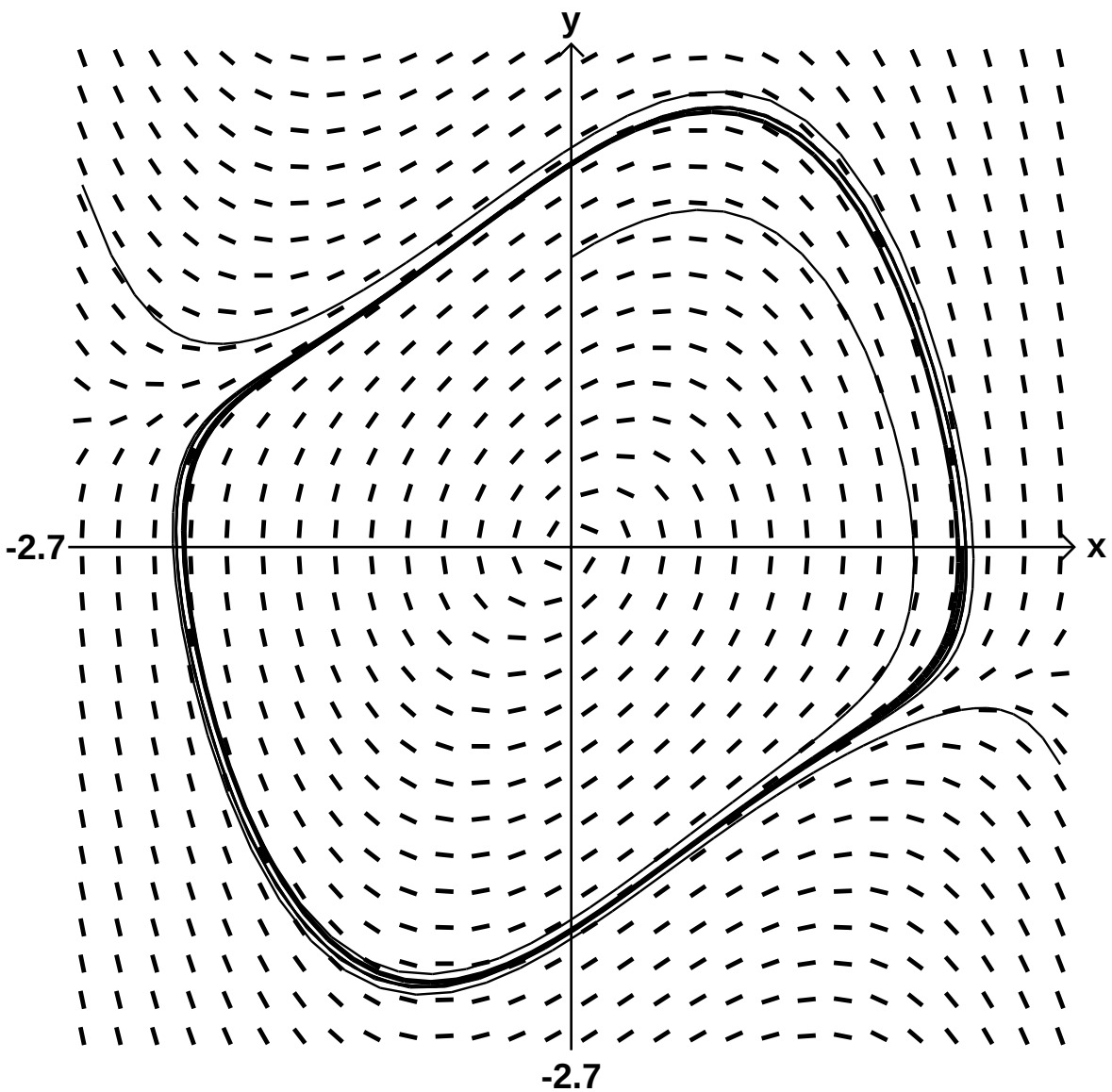
x vs y for k=0.2



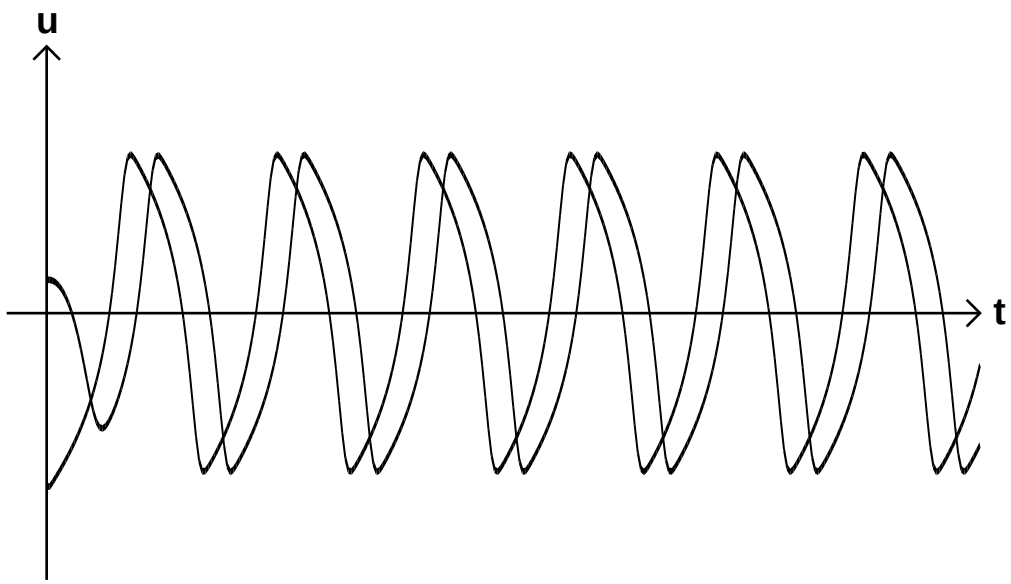
u vs t for k=0.6



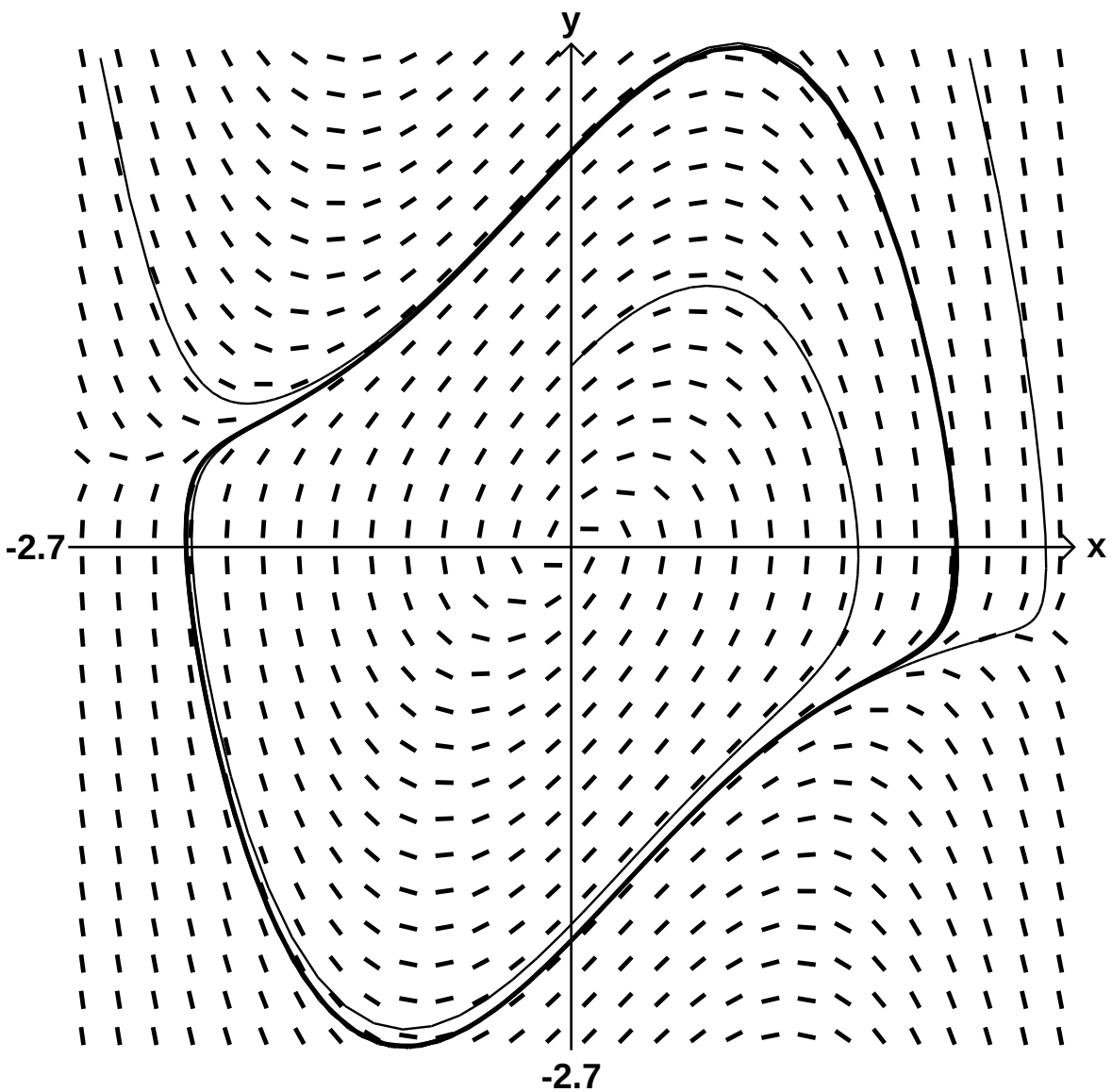
x vs y for k=0.6



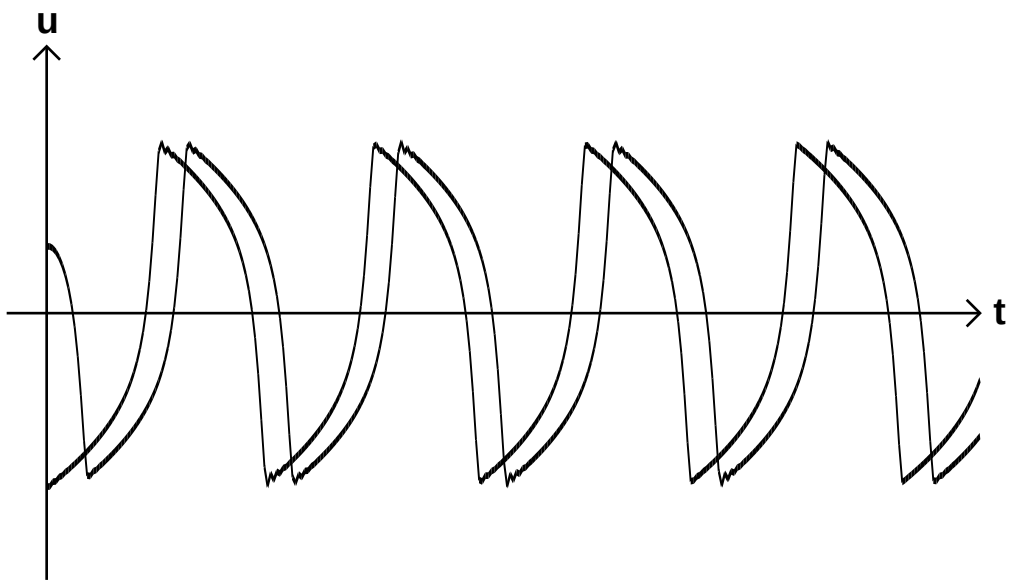
u vs t for k=1



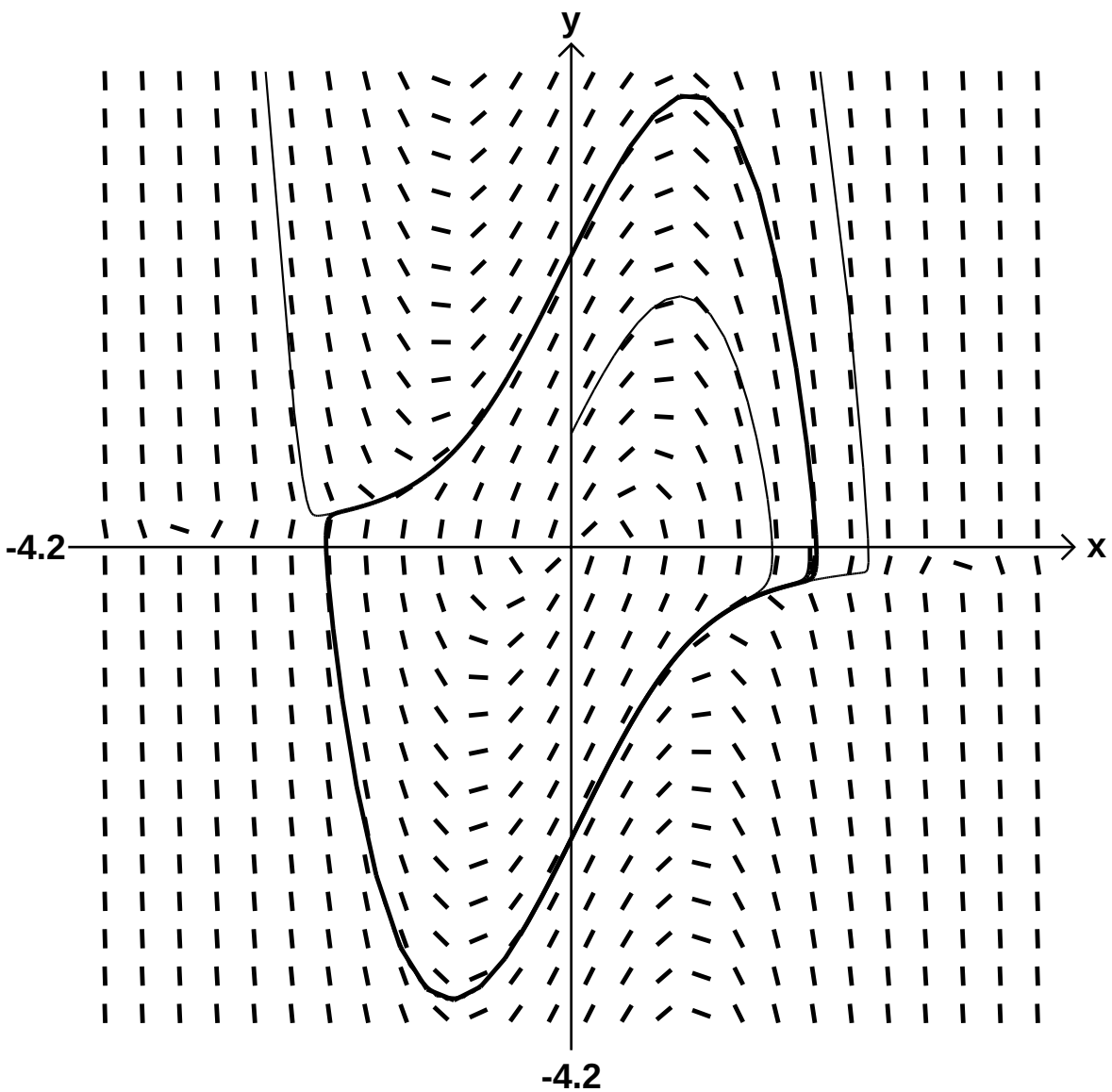
x vs y for k=1



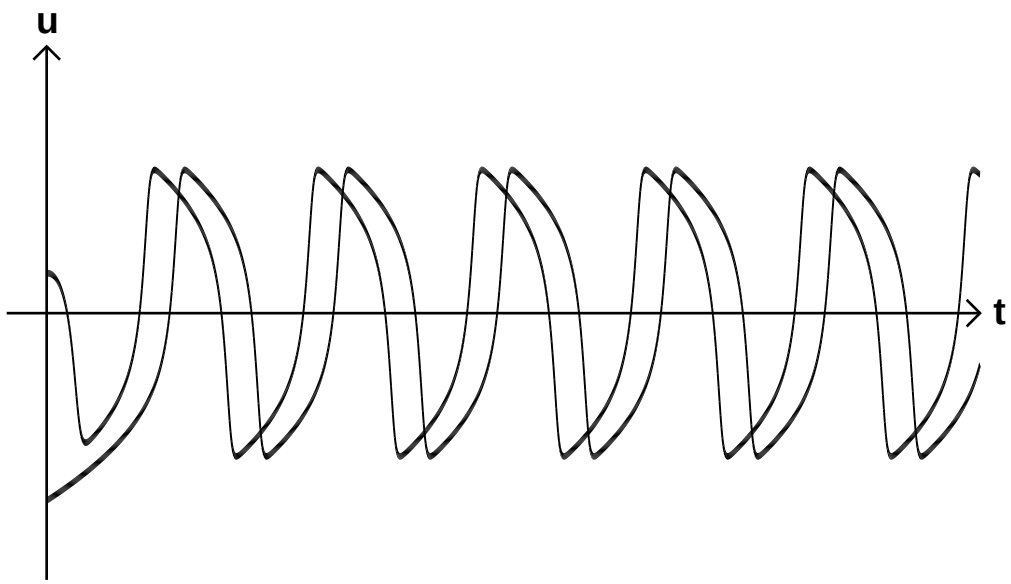
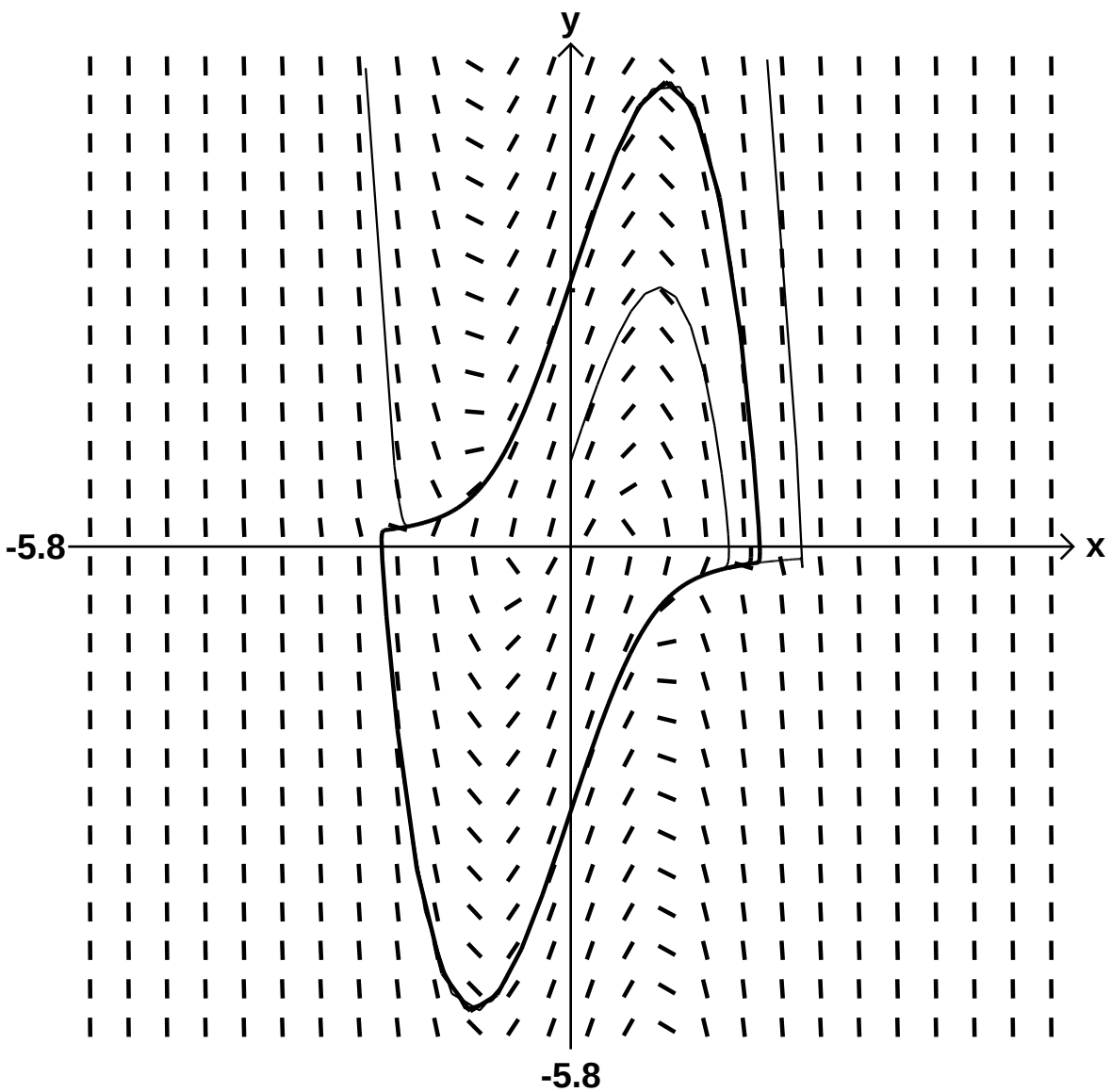
u vs t for k=2



x vs y for k=2



u vs t for k=3



x vs y for k=3