

# Model Documentation of the Winkler System

## 1 Nomenclature

### 1.1 Nomenclature for Model Equations

$x$  x-coordinate

$y$  y-coordinate

## 2 Model Equations

State Vector:

$$\underline{x} = (x \ y)^T = (x_1 \ x_2)^T$$

System Equations:

$$\dot{x}_1 = 2x_2 \tag{1a}$$

$$\dot{x}_2 = (x_1 + x_2)(-(x_1 - x_2)^2 + 1) \tag{1b}$$

## 3 Derivation and Explanation

The Winkler System is nonlinear and unstable. It has three rest positions, one spiral source in  $(-1, 0)$ , one spiral source in  $(1, 0)$  and one saddle point in  $(0, 0)$ . You can recognize the symmetry to the point of origin.

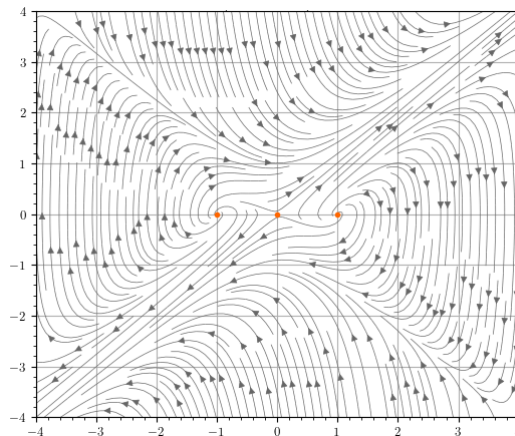


Figure 1: Phaseplane

## 4 Simulation

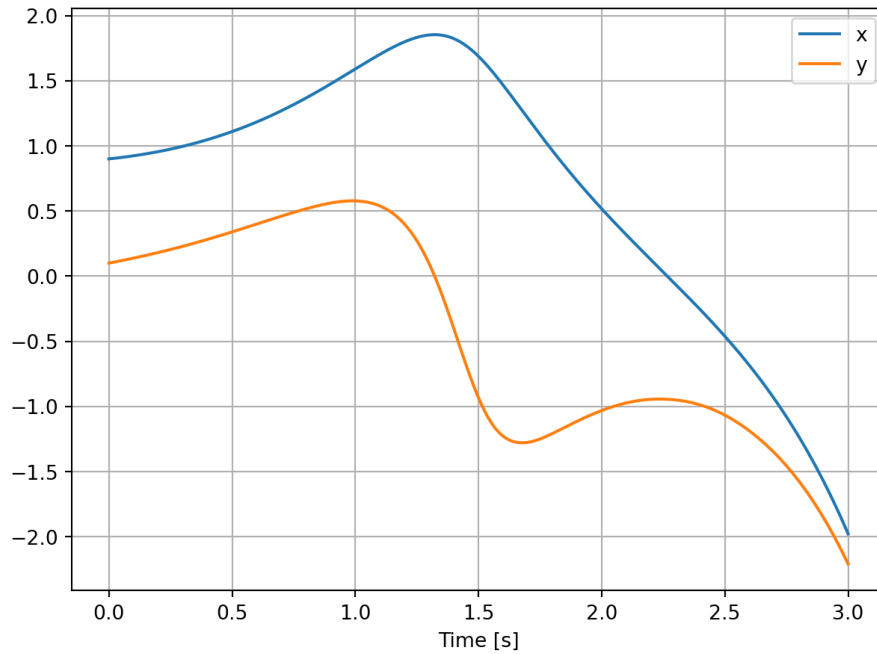


Figure 2: Simulation of the Winkler System.

## References

- [1] Winkler, Jan: *Lecture Notes "Nonlinear Control Systems 1"*, Institut of Control Theory TU Dresden, published 2022.