Switched Gain Control

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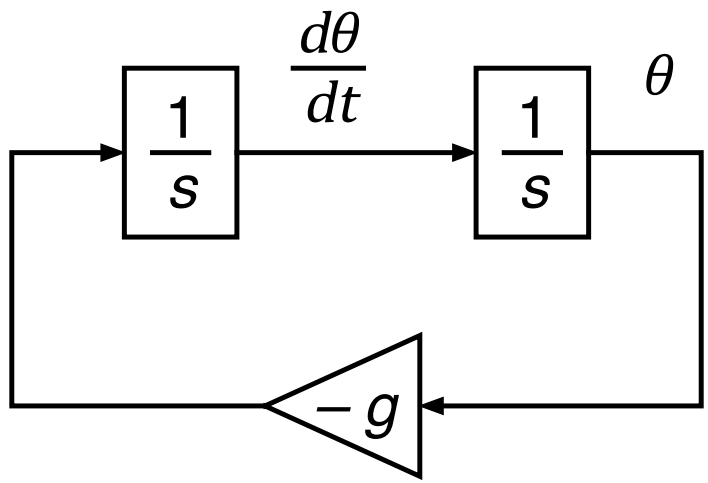
ELEC-7560

System diagram

Consider the second-order oscillator:

$$\ddot{\theta} + g = 0$$

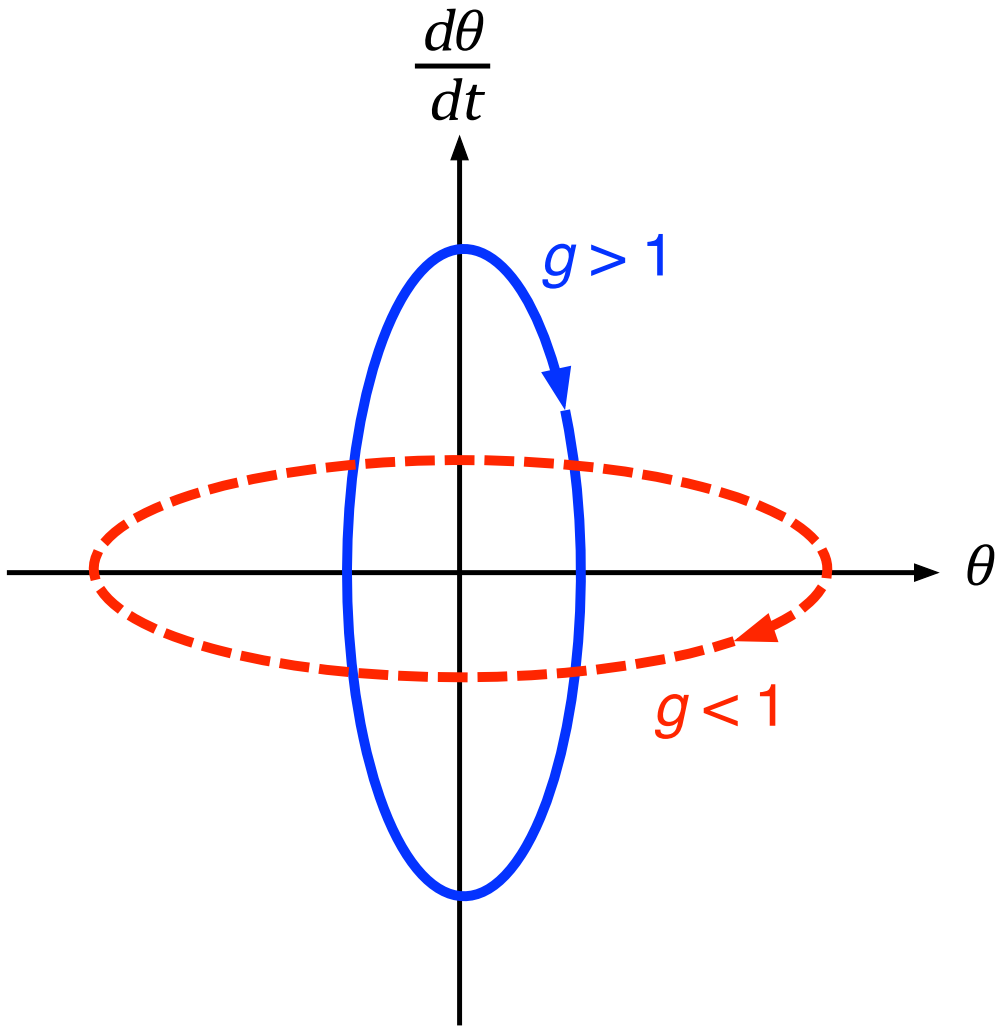
Block diagram:



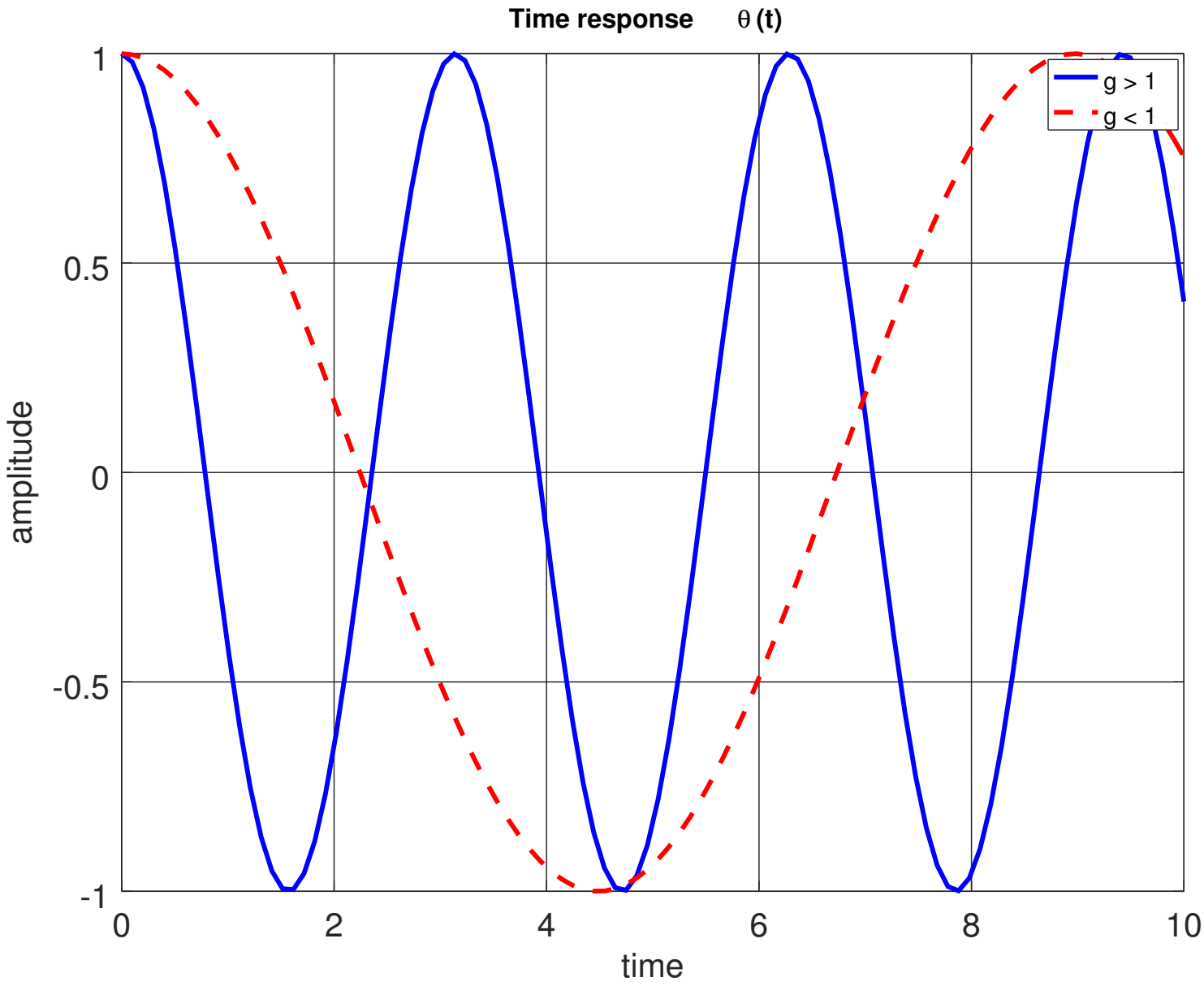
Characteristic equation roots: $s = \pm j\sqrt{g}$

Phase portrait

Consider two cases of parameter g:



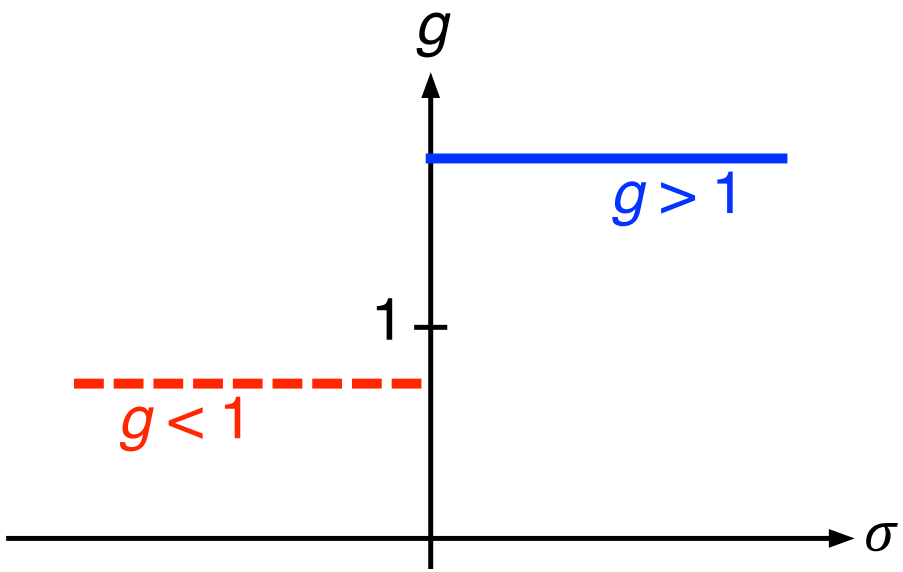
Natural responses vs. time



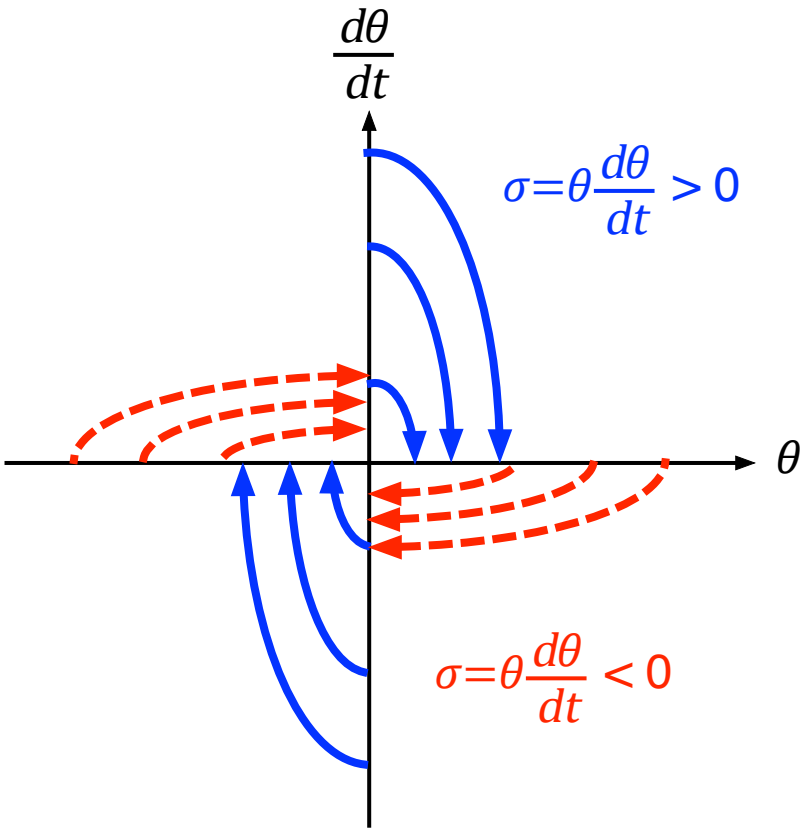
Consider a switched parameter g

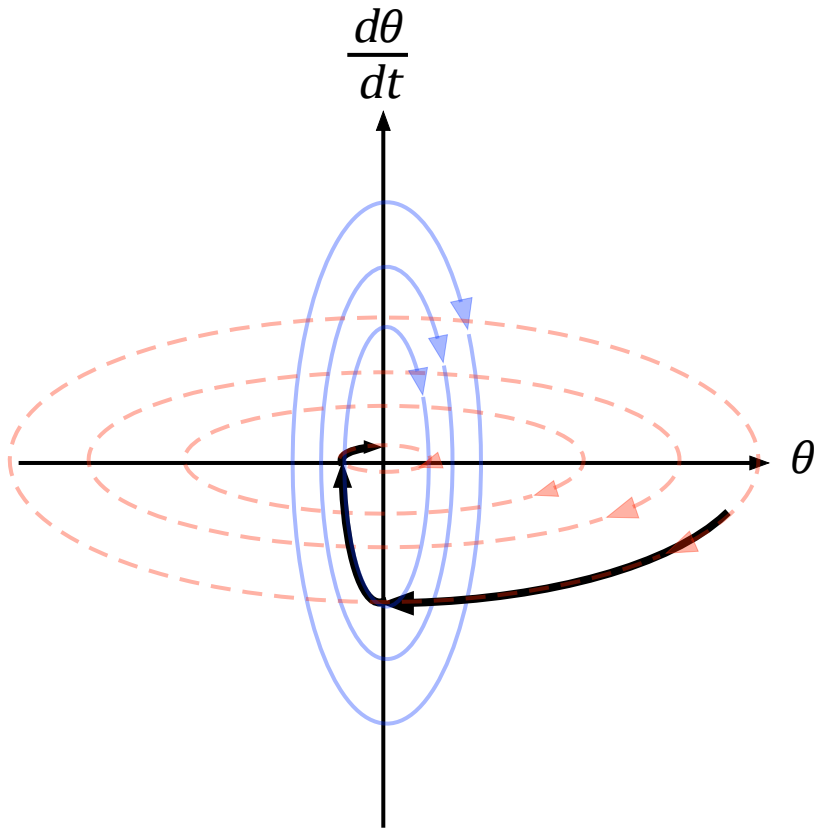
Define a "switching function" $\sigma = \theta\dot{\theta}$. Choose parameter g as:

$$g = \begin{cases} > 1 & , \sigma > 0 \\ < 1 & , \sigma < 0 \end{cases}$$



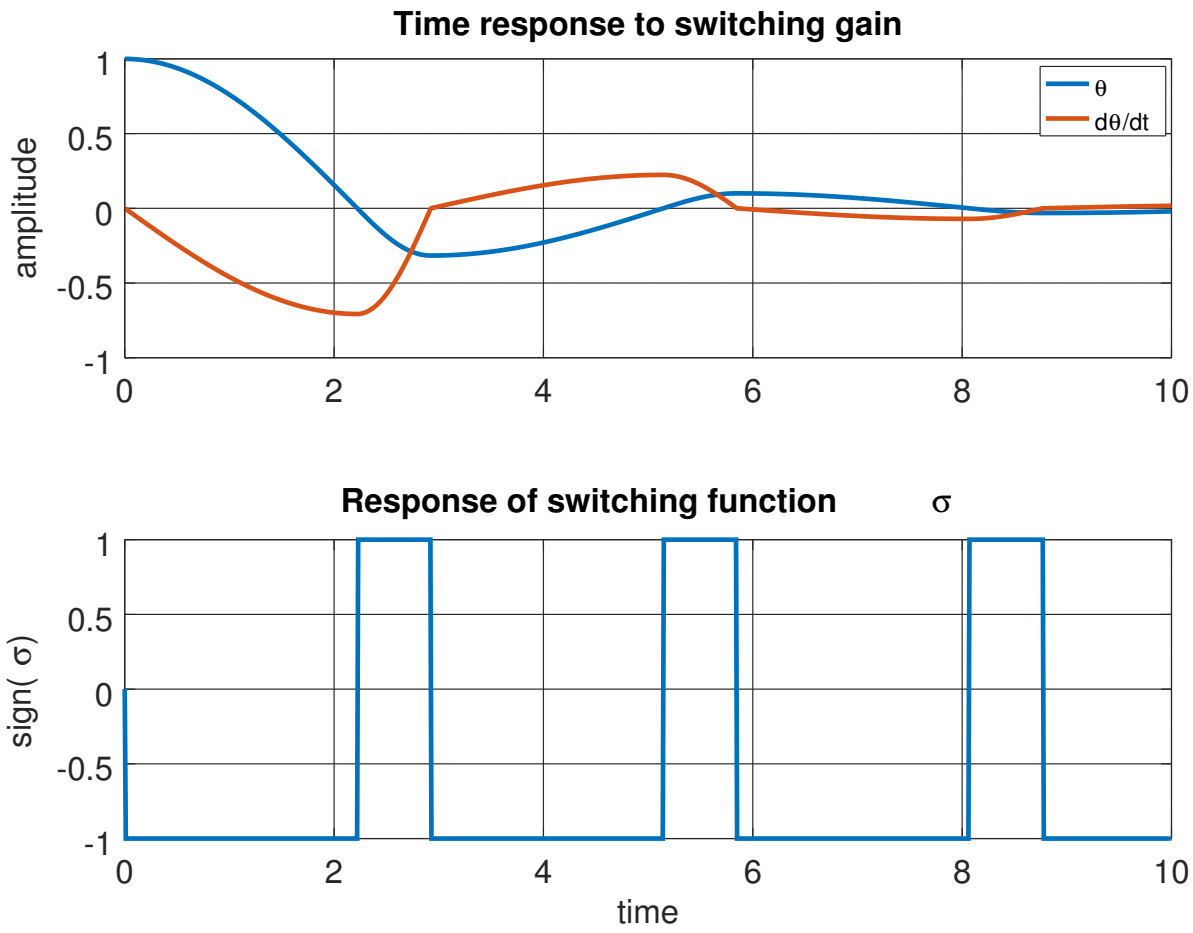
Phase portraits with switched parameter g



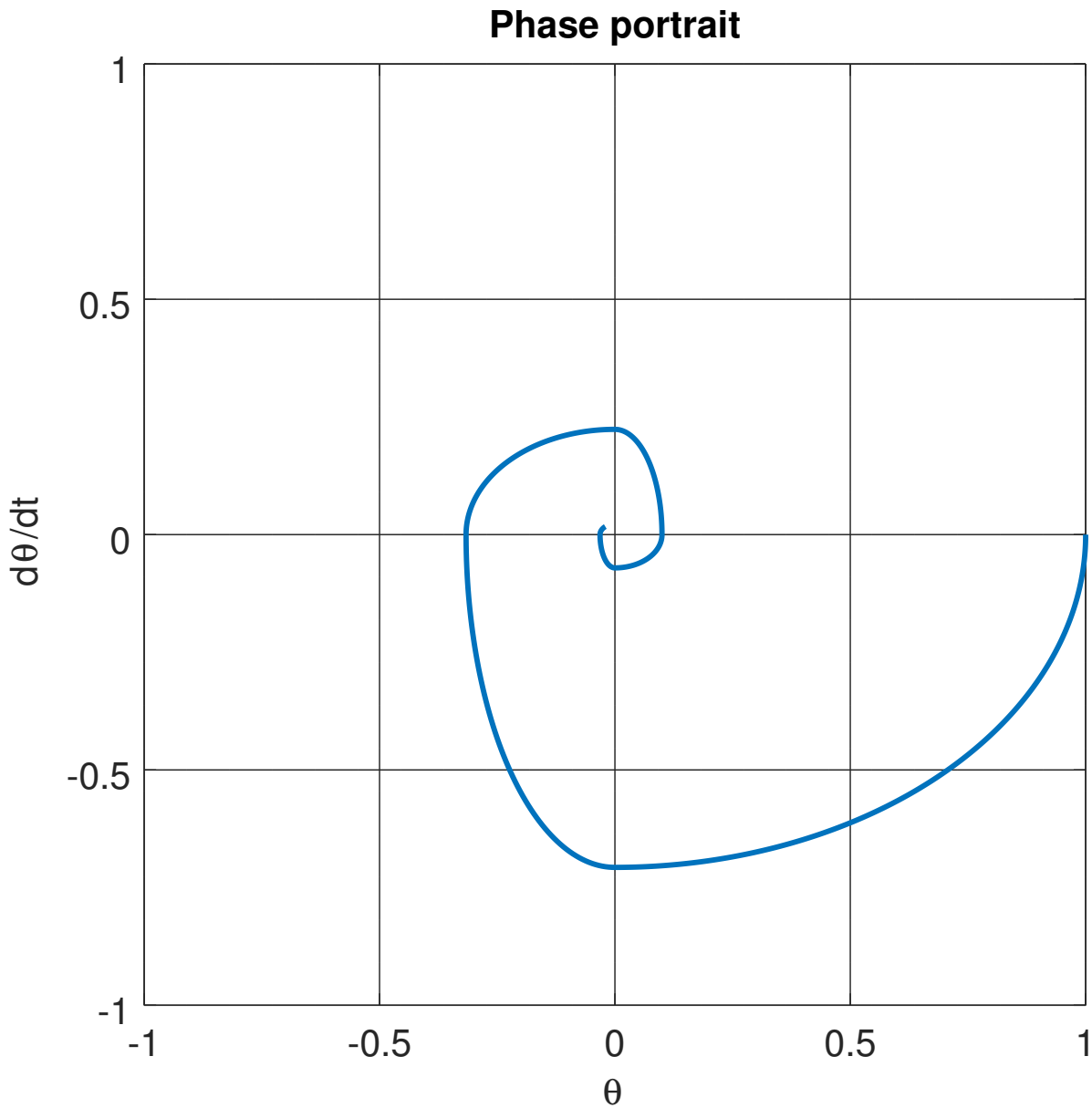


Simulation outcomes

$$g = \begin{cases} 5 & , \sigma > 0 \\ 0.5 & , \sigma < 0 \end{cases}$$



Simulated phase portrait



Some observations

- Natural responses with fixed gain g are stable, but not asymptotically stable.
- Responses using switching gain g are asympotically stable!
- Switching "surface" is defined by the equation $\sigma = 0$.
- Gain switches when σ changes sign.
- Vector fields near the surface are defined by the process.

Q1: Are other switching surfaces possible?
Q2: Can vector fields near the surface be changed?