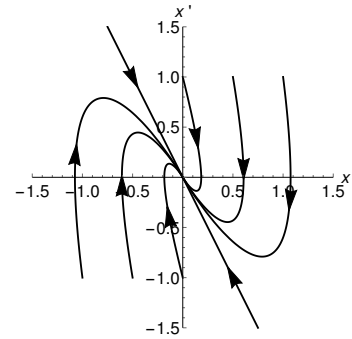


4. [14 points] Consider a mass-spring system modeled by

$$x'' + 4x' + \alpha x = 0.$$

- a. [5 points] Suppose that the phase portrait for the system is that shown to the right, below. For what values of α , if any, will the system have this type of behavior? Explain.



- b. [3 points] For what values of α , if any, will the system be underdamped? Critically damped? Overdamped? Explain how you obtain your answers.
- c. [6 points] Let $\alpha = 6$. How will the phase portrait for the system in this case differ from that given in (a)? Sketch the phase portrait for this case. In a separate graph, sketch representative solutions $x(t)$ as functions of time for the case $\alpha = 4$. (Note that you do not need to solve the problem to do this.)