Lecture 3: Energy functions and passivity

Using ”energy” as a concept for characterizing system behavior

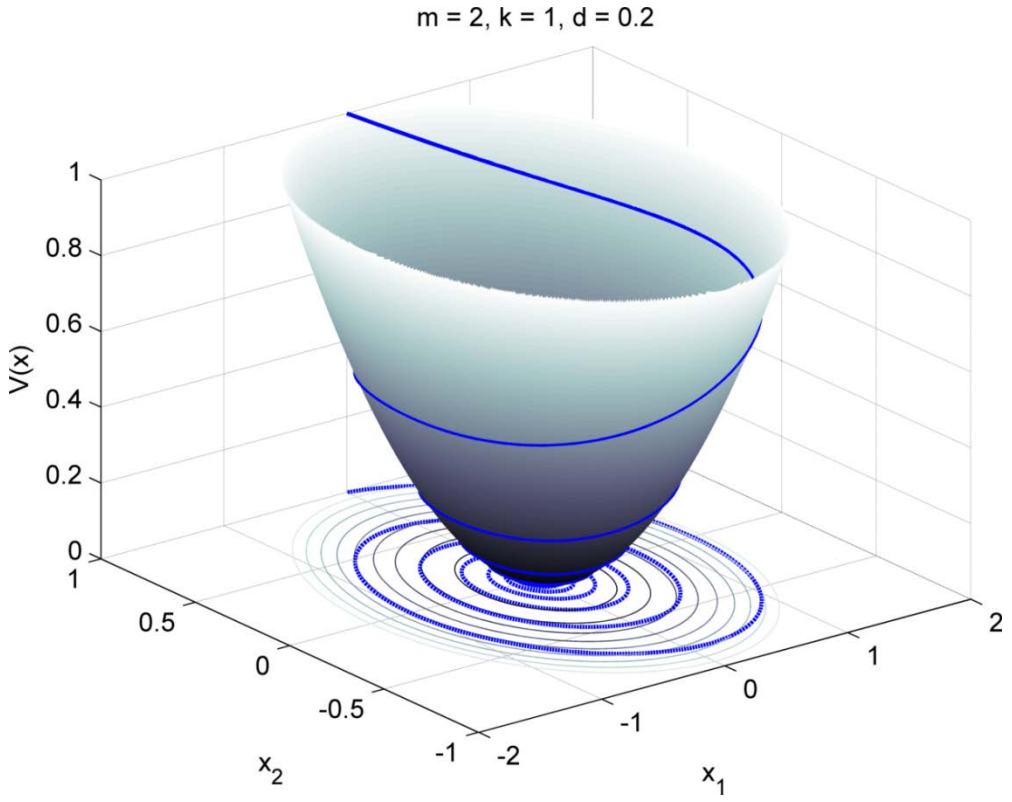
- Energy functions (aka Lyapunov functions)
  - If the ”internal energy” of a system decreases, the system is stable
  - ”Introvert” (not concerned with surroundings)
- Passivity
  - Does a system produce ”energy” to its surroundings?
  - ”Extrovert” (mainly concerned with surroundings, via inputs and outputs)
- The above concepts are connected via storage functions (next time)

Book: E2.3, E2.4

Mass-spring-damper

$$m\ddot{x} + d\dot{x} + kx = 0$$

$$V(x) = \frac{m}{2}\dot{x}^2 + \frac{k}{2}x^2$$



Why learn about passivity? Preview...

- Say you have several systems (or models), and you want to interconnect them
  - For instance, a process and a controller, or a motor and a load, or two buffer tanks in series, ...
  - Will the interconnection be stable?

- Bad news: The interconnection of stable systems is not necessarily stable

- **Good news: The interconnection of passive systems is passive (and therefore stable)!**