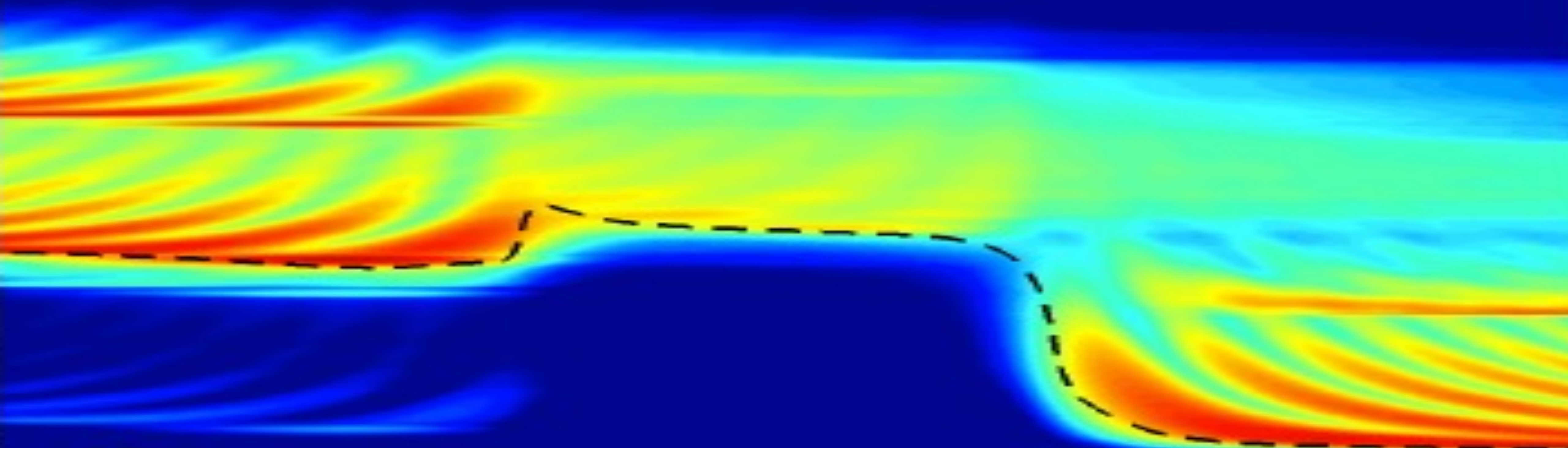

EECS 16B
Designing Information Devices and Systems II
Lecture 26

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Outline

- Linearization of Nonlinear Control Systems
    - Operating points
    - Scalar case and an example
    - Vector case and an example

Nonlinear Autonomous Systems: Equilibrium Points

$$\frac{d\vec{x}(t)}{dt} = \vec{f}(\vec{x}(t)) \ \in \mathbb{R}^n$$

$$\vec{x}[i+1] = \vec{f}(\vec{x}[i]) \ \in \mathbb{R}^n$$

Nonlinear Control Systems: Operating Points

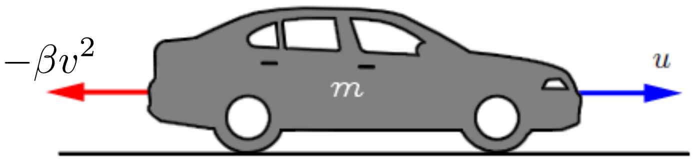
$$\frac{d\vec{x}(t)}{dt} = \vec{f}(\vec{x}(t), \vec{u}(t)) \;\; \in \mathbb{R}^n$$

$$\vec{x}[i+1] = \vec{f}(\vec{x}[i], \vec{u}[i]) \;\; \in \mathbb{R}^n$$

Nonlinear Control Systems: Linearization

Scalar case: $\frac{dx(t)}{dt} = f(x(t), u(t)) \ \in \mathbb{R}$

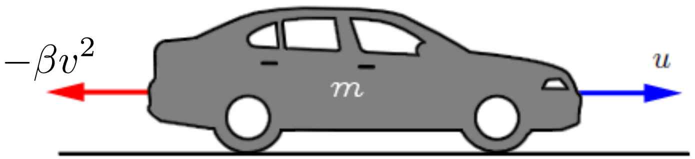
Nonlinear Control Systems: Example



$$m\frac{v(t)}{dt} = -\beta v(t)^2 + u(t)$$

$$\frac{dx(t)}{dt} = -\frac{\beta}{m}x(t)^2 + \frac{1}{m}u(t) = f(x(t), u(t))$$

Nonlinear Control Systems: Example



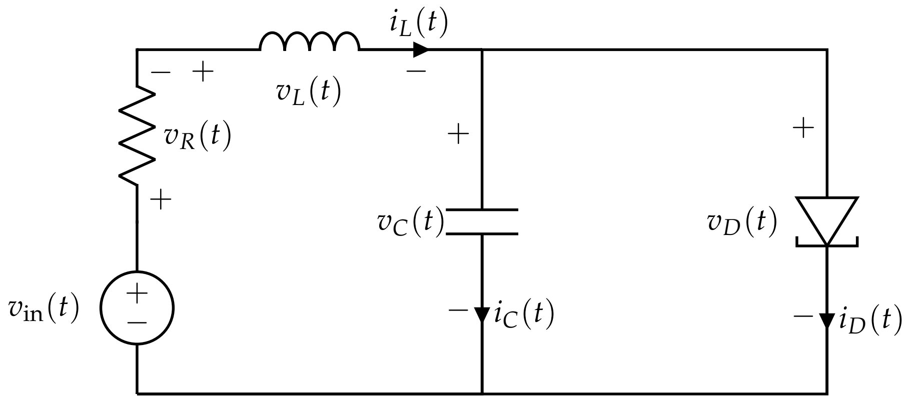
$$\frac{dx(t)}{dt} = -\frac{\beta}{m}x(t)^2 + \frac{1}{m}u(t) = f(x(t), u(t))$$

Nonlinear Control Systems: Linearization

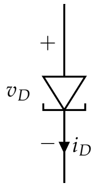
Vector case: $$\frac{d\vec{x}(t)}{dt} = \vec{f}(\vec{x}(t), \vec{u}(t))$$

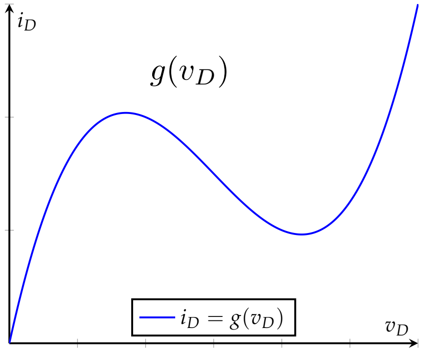
Nonlinear Control Systems: Linearization

Example: $\dfrac{d\vec{x}(t)}{dt} = \vec{f}(\vec{x}(t), \vec{u}(t))$



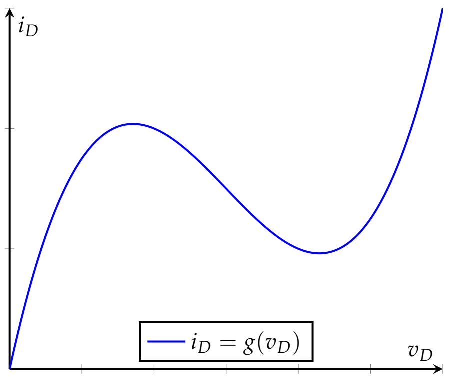
a tunnel diode

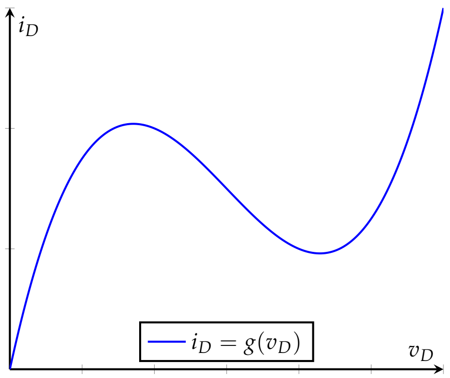


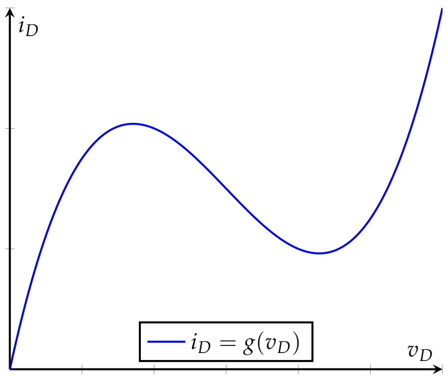


Nonlinear Control Systems: Linearization

Example: operating points.

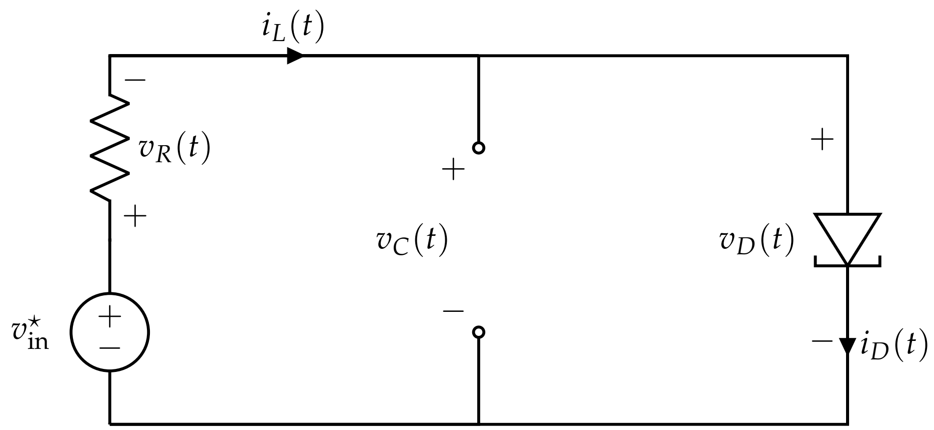






Nonlinear Control Systems: Linearization

Example: interpretation of operating points.



Nonlinear Control Systems: Linearization

Example: linearized system.

Nonlinear Control Systems: Linearization

Example: stability and controllability of the linearized system.