

STABILITY THEORY OF DYNAMIC SYSTEMS

METU EE555 - FALL 2025

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Scope: This course aims to cover some of the standard methods used in the stability analysis of nonlinear systems.

Prerequisite: Some knowledge of Linear Systems (EE502) is assumed.

Textbook: H.K. Khalil. *Nonlinear Systems (Third Edition)*. Prentice Hall, 2002.

Tentative course outline:

I. *Basic concepts*

- Examples of nonlinear models
- Second-order systems: phase plane, multiple equilibria, limit cycles
- Fundamental properties of differential equations: existence/uniqueness, finite escape time

II. *Lyapunov Theory*

- Lyapunov functions
- Linearization
- Invariance principle
- Converse theorems

III. *Various design and analysis tools*

- Backstepping
- Input-to-state stability
- \mathcal{L} -stability
- Small-gain theorem
- Passivity

IV. *Discrete-time systems*

- Lyapunov Theory
- Deadbeat observer