Dynamical system theory for engineers

Summary
Linear and nonlinear dynamical systems are found in all fields of science and engineering. After a short review of linear system theory, the class will explain and develop the main tools for the qualitative analysis of nonlinear systems, both in discrete-time and continuous-time.

Content
- **Introduction**: Dynamics of linear and non-linear systems. Definitions; Unicity of a solution; Limit Sets, Attractors.
- **Linear Systems**: Solutions; Stability of autonomous systems, Geometrical analysis, connection with frequency domain analysis.
- The class is methodology-driven. It may present some limited examples of applications, but it is not application-driven.

Keywords

Learning Prerequisites

Required courses
- Linear algebra (MATH 111 or equivalent).
- Analysis I, II, III (MATH 101, 106, 203 or equivalent).
- Circuits & Systems II (EE 205 or equivalent) or a Systems & Signals class (MICRO 310/311 or equivalent).

Recommended courses
- A first-year Probability class, such as MATH-232, MATH-231, MATH-234(b), MATH-234(c), or equivalent.
• Analysis IV (MATH 207 or equivalent)

**Important concepts to start the course**

• Linear Algebra (vector spaces, matrix operations, including inversion and eigendecomposition).
• Calculus (linear ordinary differential equations; Fourier, Laplace and z-Transforms).
• Basic notions of topology.
• Basic notions of probability.

**Learning Outcomes**

By the end of the course, the student must be able to:

• Analyze a linear or nonlinear dynamical system.
• Anticipate the asymptotic behavior of a dynamical system.
• Assess / Evaluate the stability of a dynamical system.
• Identify the type of solutions of a dynamical system.

**Teaching methods**

• Lectures (blackboard), 2h per week
• Exercise session, 1h per week.

**Expected student activities**

Exercises in class and at home (paper and pencil, and Matlab)

**Assessment methods**

1. Mid-term 20%
2. Final exam 80%

**Supervision**

Office hours  Yes
Assistants  Yes
Forum  Yes

**Resources**

**Bibliography**
Course notes; textbooks given as reference on the moodle page of the course.

**Notes/Handbook**
Course notes, exercises and solutions provided on the moodle page of the course.

**Moodle Link**

**Prerequisite for**

Classes using methods from dynamical systems.