Course: Dynamical systems

Course instructor(s): Jelena V. Manojlović

Course type (compulsory/elective): elective

ЕЦТС: 12 ECTS

Prerequisites: none

Course objectives: Course focuses on nonlinear dynamics with applications. It emphasis on geometric thinking, computational and analytical methods and makes extensive use of demonstration software. It focuses on applications of nonlinear dynamics to different disciplines, e.g., ecology, engineering, neurobiology, and fluid dynamics.

Learning outcomes: Student should gain a thorough knowledge of the theory of nonlinear dynamic systems, understand basic concepts related to a geometric and global way of thinking and should be able to use various analytical methods in nonlinear dynamics. In particular, the student should be able to test the stability of nonlinear dynamic systems with the use of software packages for graphic interpretation of the phase portraits.

Course description (outline):

- Phase portraits of linear systems in the plane. Topological classification of dynamical systems. Constructing Phase Plane Diagrams.
- Linearization and Hartman's Theorem. Existence and nonexistence of limit cycles in the plane. Poincare-Bendixson Theorem. Poencare map. Stability and Liapunov functions.Center manifold theory. Normal form theory
- Bifurcation of one-dimensional and two-dimensional dynamical systems
- Three-dimensional dynamical systems and chaos: The Rossler system and chaos. The Lorenz equation and attractor. Chua's Circuit.
- Chaos on strange attractors: Lyapunov exponent. Chaotic orbits. Strange attractors.

References:

1. L. Perko**,** Differential Equations and Dynamic Systems, Springer, 1991.
2. M.W.Hirisch, S. Smale, R.L. Devaney – Differential equations, Dynamical systems & An Introduction to Chaos, Second Edition, Elsevier Academic Press, 2004.
3. Stephen Lynch, *Dynamical Systems with Applications using Mathematica*, Birkhauser, Boston, 2007.
4. S. H. Strogatz, *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering*, Perseus Books Publishing, 1994

Active teaching hours: 5	**Theoretical classes:** 5	**Practice classes:**

Methods of teaching:

Lectures are conducted using conventional teaching methods in interaction with the students. Knowledge of students is tested through homeworks and preparation and defense of seminar papers. Oral exam checks the understanding of the whole course material.

Grading structure

Pre-exam obligations	**Points**	**Exam**	**Points**
Colloquia Seminars	**40**	Oral exam	**40**