Chaos and Non-Linear Phenomena

Programme course

6 credits

Kaos och icke-linjära fenomen

TFYA36

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Mathematics, Applied Mathematics, Applied Physics, Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
-
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanoscience, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering

Specific information
The course is offered every second year. It will not be available during 2017.

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Linear algebra, Modern Physics, Classical Mechanics and some knowledge of Fourier Analysis and Partial Differential Equations. Analytical Mechanics, Quantum Mechanics and Physics of Condensed Matter are recommended.

Intended learning outcomes

The aim of the course is that the students should get an orientation in the special properties of non-linear systems of theoretical and practical interest, and also an orientation in some topical areas of research.

After finishing the course the student knows how to:

- explain basic concepts in non-linear physics such as chaos, fractal dimensions, integrability, solitons and quantum chaos, and exemplify important applications of these concepts in different scientific disciplines.
- model simple non-linear dynamical systems mathematically, and demonstrate some of their characteristic properties by analyzing bifurcations and calculating Lyapunov-exponents and fractal dimensions for their attractors.
- explain mechanisms for appearance of chaos in conservative systems and properties of the corresponding quantum mechanical systems, and solve problems by applying the theory for Hamiltonian systems on simple models.
- derive soliton solutions in special mathematical models for wave motion in non-linear media, and exemplify their physical significance.

Course content

Introduction. Experiments and simple models. Vibrations in mechanical systems and electrical circuits. Piecewise linear maps and deterministic chaos. Universal behavior of quadratic maps. Bifurcations. Poincaré maps. Lyapunov exponents. Fractal dimensions. Period-doubling. Homoclinic and heteroclinic orbits. The intermittency route to chaos. Strange attractors in dissipative dynamical systems. The transition from quasiperiodicity to chaos. Regular and irregular motion of conservative systems. Integrable and non-integrable systems. Solitons and breathers with applications. Chaos in quantum systems.

Teaching and working methods

The course consists of lectures and exercises solving problems.

Examination

UPG2	Oral Presentation of Solved Problems	0.5 credits	U, G
UPG1	Hand-in assignments	5.5 credits	U, 3, 4, 5

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent
Magnus Johansson

Examiner
Magnus Johansson

Course website and other links
http://www.ifm.liu.se/courses/tfya36/kaos.html

Education components
Preliminary scheduled hours: 56 h
Recommended self-study hours: 104 h

Course literature

Additional literature

Compendia
G. Ohlén/S. Åberg/P. Östborn, Chaos
Compendium, Lund

Other
Complementary material handed out during the course.

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.