Siberian Federal University

Mathematical Modeling

Course Syllabus

Krasnoyarsk, 2019

Basic Information

This is a course, which contributes to MSc award in Mathematics

Duration	216 hours (6 ECTS)
Starting date	September, 1st
Study credits	6 ECTS credits
Language of instruction	English level B1 (European Framework of Reference od Communicative Skills)
Academic requirements	BSc degree in Mathematics, Physics, Computer Science, Engineering or equivalent

Course Description

Course Overview

The course covers the fundamental ideas and tools of mathematical modeling. It is designed with emphasis placed on the modeling of nonlinear phenomena. A particular feature of the course is an extensively using of computer algebra systems and other mathematical software during the learning process. The topics will include dynamical systems, stochastic modeling and partial differential equations. Modeling applications from physics, biology, chemistry and other areas will be discussed in great detail.

Special Features of the Course

Mathematical modeling is an important tool for investigation of world. The methods of mathematical modeling can be applied in wide area of applications. Institute of Space and information technologies of Siberian federal university has all necessary software needed to success learning the course.

Course Aim

The course is aimed to enable students to experience of real-world problems solving by means of concepts of mathematical modeling.

Course Objectives

The objective of the course is to produce graduates with a rigorous foundation in the mathematical modeling and with practical ability to using of mathematical modeling methods.

Learning Outcomes

By the end of the course students should be able to:

- develop mathematical models that can be effectively analyzed;
- carry out appropriate mathematical analysis;
- present and interpret obtained results.

Lecturer Contact information

Shmidt A.V., PhD in Mathematics,

Web-page: https://scholar.google.ru/citations?user=Ie3bOMAAAAAJ&hl=en

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Prerequisites

The students who take this course should have basic knowledge of ordinary differential equations theory.

Preliminary Reading

Hartman P. Ordinary Differential Equations. John Wiley & Sons, New York.1964.

Course Outline

Course Requirements

Required Texts:

Samarskii A. A., Mikhailov A.P. Principles of Mathematical Modeling. Ideas, Methods, Examples. London and New York. Taylor and Francis, 2002, 349 p. ISBN 0-415-27280-7.

Strogatz S.H. Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014, 528 p., ISBN: 9780813349107.

Gardiner C. Stochastic Methods. Springer-Verlag Berlin Heidelberg, 2009, 447 p., ISBN: 978-3-540-70712-7.

Heinz S., Mathematical Modeling, Springer, 2011, e-ISBN: 978-3-642-20311-4

All the books are available on-line at SFU library.

Required Feedbacks:

You are encouraged to typeset the homework using LaTeX typeset system. The corresponding PDF files must be sent by Email to the Course Instructor for checking.

Course Structure

Learning Activities	**Hours**
Lectures	18
Practice sessions / Seminars	36
Self-study Assignments	126

Final Exam (including preparation)	36
Total study hours	**216**

Course Topics

Week	Lectures	Practice session / Assignments	Hours
1-2	Basics of mathematical modeling	− Basic concepts mathematical modeling − Stages of mathematical modeling − Home assignment No 1	18
3-6	Dynamical systems	− Theory of stability − Limit cycles − Self-oscillations − Van der Pole generator − Lorenz system − Home assignment No 2 − Home assignment No 3 − Home assignment No 4	54
7-9	Modeling of chemical reactions	− Basic concepts of chemical kinetics − Method of quasi-equilibrium concentrations − Law of Arrhenius − Home assignment No 5 − Home assignment No 6	36
10-12	Population dynamics	− Malthus, logistic, and Volterra models − Home assignment No 7	24
13-15	Stochastic modeling	− Stochastic processes − Markov chains with continuous and discrete time − Home assignment No 8	24
16-18	Financial and economic modeling	− Modeling of financial processes − Modeling of economic processes − Home assignment No 9	24
18	Final exam		36

Assessment

Student's grades will be based on the following scheme: 30% Homework assignments, 20% Presentations, 50% Final Examination.

Grade policy for practical home assignments, presentations and the final exam is: A (excellent work) 91–100 points, B (above average work) 81–90 points, C (average work) 71–80 points, D (below average work) 50–70 points, F (failed work) < 50 points.

The exam is taken orally. Each exam ticket consists of 2 theoretical questions from the list of exam questions.

Attendance Policy

Students are expected to attend all classes. In the case you are unable to attend the class, it is under your responsibility to contact the course instructor for the purpose of getting individual instructions for the missed class(es). If you know you are going to miss the class, please contact the course instructor. Missed classes must not exceed a quarter of the total course time.

Required Course Participation

Although the theoretical material required to complete successfully the course is accessible online, students are encouraged to attend classes and participate in discussions.