Course title	**Mathematical modelling and differential equations I**
Course code	Mate3008
Branch of science	Mathematics
Sub-branch	Mathematical modelling
Credit points	2
ECTS credit points	3
Total contact hours Lectures Seminars	32 16 16

Course author
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Prerequisites (course title, part of the program)
Mate1009, Mate1012, Mate2003, Mate2012

Course abstract
This course is designed for Bachelor study program "Mathematics" students. The aim of the course is to introduce students to the basic methods of mathematical modeling using differential equations. The concept of mathematical modeling will be considered. Using the first and the second order ordinary differential equations the biological population models, linear second-order oscillation models, as well as super-linear and sub-linear oscillators will be analyzed.

Results

- be able to analyze qualitatively the first order ordinary differential equations (ODE);
- solve the first order ODE and analyze the related models;
- classify the second order ODE;
- be able to analyze linear oscillation models and nonlinear oscillators;
- be able to carry out analytical calculations for super-linear and sub-linear oscillators.

Course content:

Lectures – 16 contact hours, seminars – 16 contact hours.

The concept of mathematical modeling. Main requirements. Examples. Types of mathematical models. Ordinary and partial differential equations. Classification of differential equations. First-order differential equations. Analytical solving methods. Qualitative analysis. Direction field. Biological population models. Second-order linear differential equations. General solution and energy. Examples of mechanics. Periodic processes in nature. Oscillators.

Course plan:

Lecture topics

1. The concept of mathematical modeling. Ordinary and partial differential equations.
2. Classification of differential equations. First-order ordinary differential equations and its analytical solving methods.
3. Qualitative analysis of a differential equation. Direction field.

4. Biological population models without restrictions. Interpretation and analysis.
5. Biological population models with restrictions. Logistics equation.
6. Second-order ordinary differential equations: linear, homogeneous, inhomogeneous.
7. Linear oscillations. Forced oscillations. Resonance.
8. Nonlinear oscillations. Mechanic models. Conservative systems. Energy. Oscillators.

Seminar topics

1. First-order ordinary differential equations. Direction field.
2. Analytical solving of the first order linear ordinary differential equations.
3. Qualitative analysis of the first order ordinary differential equations.
4. Analysis of biological population models.
5. Second-order liner ordinary differential equations.
6. Boundary value problems for second-order differential equations.
7. Linear oscillations.
8. Nonlinear second-order differential equations. Nonlinear oscillation.

Independent work of students:
The course provided a systematic control tasks solving. During semester students must complete 2 independent works. For each student tasks are individual. All entries must be satisfied and positively evaluated by the beginning of the session.

Course requirements:

Acquisition and presentation of knowledge and skills described within the course.
Final evaluation form for the course – differentiated pass..
Course requirements – regular attendance and active work in 40%, independent work execution of 60%.
Study methods and forms – lectures, seminars, independent work.

Mācību pamatiteratūra :

1. R. Agarwal, D. O'Regan. An introduction to ordinary differential equations. Springer, 2008.
2. K. Alligood et al. Chaos: An introduction to dynamical systems, Springer, 2000.
3. L. Perko. Differential equations and dynamical systems, Springer, 3rd Edition, 2006.
4. P.E. Phillipson, P. Schuster. Modelling by nonlinear differential equations, World Scientific, 2009.
5. R.E. Mickens. Truly nonlinear oscillations, World Scientific, 2010.
6. Edited by I. Kovacic and M. J. Brennan. The Duffing Equation: Nonlinear oscillators and their behaviour, Wiley, 2011.
7. J.J. Stoker. Nonlinear vibrations in mechanical and electrical systems, Wiley, 1992.
8. S. Čerāne. Diferenciālvienādojumi un modeļi, Rīga, 1999.
9. S. Čerāne. Diferenciālvienādojumi, Rīga, 2002.

Papildliteratūra:

Periodika un citi informācijas avoti:

Atslēga, Svetlana. Diferenciālvienādojumi. Fāzes portreti [elektroniskais resurs] : [mācību līdzeklis] / Svetlana Atslēga, Feliks Sadirbajevs; Daugavpils Universitāte, Matemātikas katedra. – Tiešsaistes grāmata. – Daugavpils : DU, 2007. – 46 lpp. - Pieejas veids : tīmeklis WWW. URL : http://www.de.dau.lv/matematika/Phase-portraits.pdf.

Piezīmes:

Kādām studiju programmām un to daļām (A, B, C, D) ir piederīgs šis kurss:
Bakalaura studiju programmas “Matemātika” B daļa.

Kursa nosaukums angļu valodā:
Mathematical modelling and differential equations I

Kursa anotācija angļu valodā:
The course aims to introduce students to the main themes and methods of mathematical modelling with differential equations. The notion and idea of mathematical modelling are defined. The mathematical models expressed in terms of the first and second order ordinary differential equations are considered. Biological population models are discussed and analyzed. The second order oscillation models of linear mechanics are studied as well as super and sublinear oscillators.