Syllabus for the course «Advanced Calculus»

Approved
MP Academic Council
Protocol №2.6-06/7 29/08/2019

1. **Course Description**
   a. «Advanced Calculus»
   b. **Pre-requisites**
      The course is based on the knowledge of the material of a standard course of a high school mathematics.
   c. **Bridging Course**
   d. **Abstract**
      The bridging course “Advanced Calculus” has an aim to train the master students to be ready for the courses devoted to Bayesian Statistics, Qualitative and Quantitative Research Methods in Psychology, Computational Neuroscience, Digital Signal Processing and some others. In the framework of this course the students study the theory of derivatives and integrals, differential equations and dynamical systems, Taylor, Fourier and Laplace series.
2. **Learning Objectives**

Learning objectives of the course "Advanced Calculus" are to introduce students to the subject of mathematics, its foundation and connections to other branches of knowledge:

- Gain understanding of the concept of functions, continuous functions and different kind of discontinuous functions.
- Gain skills in evaluating derivatives and integrals.
- Gain skills in solving of linear differential equations.
- Gain understanding of dynamical systems analysis.
- Gain understanding of Fourier series, Fourier transforms and their applications
- Gain understanding of Laplace transforms and their applications.

3. **Learning Outcomes**

After completing the study of the course "Advanced Calculus" the student should:

- Know basic notions and definitions in calculus, its connections with other sciences.

- Know main operations, rules and properties of sets, real numbers, functions, continued functions, derivatives and integrals, Taylor series.
- Know basic methods for solving of linear differential equations
- Know basic facts about Fourier series, Fourier transforms and their applications
- Know basic facts about Laplace transforms and their applications
- Be able to formulate common task in mathematical terms, state rigorous calculus tasks and present methods to solve it.
- Be able to analyze one dimensional and two dimensional flows.

4. Course Plan

№	Topic
1.	Special elementary functions. Limit function of one variable. Continuous and discontinuous functions.
2.	Derivatives and antiderivatives.
3.	Linear homogenous and non-homogeneous differential equations. Rules of solving.
4.	Dynamical systems. One dimensional flows: steady states, stability and bifurcations. Two dimensional flows: steady states, limit cycles, stability, bifurcations, phase portraits. Dynamical chaos.
5.	Taylor Series
6.	Fourier Analysis.
7.	Laplace transform.

5. Reading List

Required

H.Anton, Calculus. John Wiley & Sons 2002.

C.Edwards, D.Penney. Differential Equations: Computing and Modeling. 4th Edition. — David Calvis, 2008.

S.H. Strogatz, Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering (Studies in Nonlinearity). CRC Press. 2013.

6. Grading System

Final course mark is obtained from the following formula:

$$O_{final} = 0,5*O_{cumulative}+0,5*O_{exam}.$$

The grades are rounded in favour of examiner/lecturer with respect to regularity of class and home works. All grades, having a fractional part not less than 0.5, are rounded up.

Table of Grade Accordance

Ten-point Grading Scale	Five-point Grading Scale	
1 - very bad 2 – bad 3 – no pass	Unsatisfactory – 2	**FAIL**
4 – pass 5 – highly pass	Satisfactory – 3	**PASS**
6 – good 7 – very good	Good – 4	
8 – almost excellent 9 – excellent 10 – perfect	Excellent – 5	

7. Guidelines for Knowledge Assessment

The assessment consists of classwork and homework, assigned after each lecture. Students have to demonstrate their knowledge in each lecture topic concerning both theoretical facts, and practical tasks solving. All tasks are connected through the discipline and have increasing complexity.

Final assessment is the final exam. Students have to demonstrate knowledge of theory facts, but the most of tasks would evaluate their ability to solve practical examples and present straight operation and recognition skills to solve them.

8. Methods of Instruction

The following educational technologies are used in the study process:

- Seminars involving team oral discussions.
- Homework assignments.
- Self-study of recommended literature.

- Discussion and analysis of the home task results in the group.

Students are required to actively participate in oral discussions during seminars and to take all tests.

9. **Special Equipment and Software Support (if required)**