Course Syllabus

1. Course Title:

Modern Information Technologies and Analytical Computing Packages

2. Academic Level:

Master

3. ECTS Credits:

6 ECTS

4. Semester:

1, autumn semester

5. School/Department:

Institute of Mathematics, Mechanics and Computer Science

6. Location:

8a Milchakova St., Rostov-on-Don

7. Instructor:

Prof. Rostislav Nedin, email: rnedin@sfedu.ru

8. Language of Instruction:

English

9. Course Description:

The course deals with the concepts of mathematical modeling and a number of its applications in theoretical mechanics and physics. The course gives a brief introduction to Maple and its application to physics. It is aimed to the demonstration of Maple's capabilities for performing algebraic transformations, plotting charts and performing computational operations. Application of the basic principles of theoretical mechanics for the formulation of equations, the use of the Maple system for solving physical problems are discussed. The course contains fundamentals of second-order differential equations with constant coefficients for describing mathematical models of actual physical processes.

10. Course Aims:

- Training in the use of modern mathematical packages and applications for the formulation and solution of applied problems of computational algebra, theoretical mechanics and mathematical physics
- Mastering the foundations of algebra methods, differential equations and mathematical-mathematical equations for the analytical and numerical solution of applied problems in mechanics and physics
- Development of the ability to write algorithms and programs for solving the problems posed using the proposed solution methods in the mathematical package Maple, building analysis of the results of numerical and analytical solutions to problems.

11. Specific entry requirements (if any):

Students must have completed certain courses, such as “Algebra and Geometry”, “Differential equations”, “Scientific computing software packages”, “Numerical methods”, before being eligible for this course.

12. Course Content:

The concept of mathematical modeling. A brief introduction to Maple and its application to physics. Demonstration of Maple's capabilities for performing algebraic transformations, plotting charts and performing computational operations. Symbolic and numerical calculations.
Application of the basic principles of theoretical mechanics for the formulation of equations, the use of the Maple system for solving physical problems.
Fundamentals of second-order differential equations with constant coefficients for describing mathematical models of actual physical processes.
Differential equation of harmonic oscillations. Harmonic oscillator, types of oscillations. The oscillation energy of a harmonic oscillator. Phase portrait.
The course is divided into the following sections:

- Basic Algebra and Solving Equations
- Calculus
- Differential Equations
- Vectors and Matrices
- Simple Harmonic Oscillator
- Damped Oscillation
- Sinusoidally Driven Oscillation
- Phase Space

13. Intended Learning Outcomes:

On successful completion of the course, students are expected to acquire the following knowledge, skills and abilities:
Fundamentals of procedural programming, the basic methods of using the interface and writing programs for calculating applied problems; obtaining and analyzing the results of solving applied problems; bases of methods of algebra, differential equations and equations of mathematical physics for solving a number of important applied problems in mechanics and physics. Application of known methods of algebra, differential equations and equations of mathematical physics to solve specific applied problems of theoretical mechanics and mathematical physics.

14. Learning and Teaching Methods:

During the lectures, the following educational technologies are used:

- multimedia lectures with slides
- discussion
- debates

Practical part consists of practical assignments for the lectures and individual project. Practical assignments and tasks imply programming in mathematical software package Maple.

During the practice classes, the following educational technologies are used:

- use electronic study materials;
- use of mathematical software package Maple, and its technical documentation;
- electronic forms of control
- presentation of the individual project

The educational process is based on the concept of competency-based training, focused on the formation of a specific list of professional competencies and updating the acquired theoretical knowledge. The implementation of a competency-based learning model involves the widespread use of innovative ways of organizing the educational process, including the use of project-based learning methods, self-directed learning technologies, and a credit-rating system.

Classes and other forms of student contact work with the teacher can be conducted using the Microsoft Teams and MOODLE platforms, including online lectures and online seminars.

15. Methods of Assessment/Final assessment information:

Control throughout the semester: attendance at lectures, practical assignments.
Border control: individual project assignment.
Final certification: exam.

16. Reading List:

1. James W. Demmel. Applied Numerical Linear Algebra. SIAM, 1997. 184 pages.
2. Frank Y. Wang. Physics with Maple. The Computer Algebra Resource for Mathematical Methods in Physics. WILEY-VCH Verlag GmbH & Co. KGaA, 2005. 605 p.