Taras Shevchenko National University of Kyiv

Physics Department

Course description

Differential Equations

Level:	**Language:**	**Duration:**	**Occurrence:**
Bachelor	Ukrainian	2 semesters	2nd – 3rd semesters
Credits:	**Total Hours:**	**Contact Hours:**	**Self-study Hours:**
8	240	120	120

Description of Course Work and Examinations

Module-rating system, results are evaluated on a 100-point scale. Each semester contains 2 midterms 30 pts/90 min each and a final exam 40 pts/90 min.

Prerequisites

Mathematical Analysis (1st semester), Analytic Geometry and Linear Algebra (1st semester).

Syllabus

Equations of the 1st Order: equations with separable variables and those which can be reduced to the latter by substitution, homogeneous ODEs of the 1st order and those which can be reduced to the latter (Bernoulli, Riccati equations), linear ODEs of the 1st order and those which can be reduced to the latter, variation of the parameter, equations in total differentials, integrating factor, its properties and methods of finding, Cauchy problems of the 1st order, theorems of existence for implicit (Picard's theorem) and explicit Cauchy problems, equations of forms $x = f(t, x')$ and $t = f(x, x')$, Lagrange's and Clairaut's equations.

Reduction of the Equation Order: equations of forms $f\left(t, x^{(k)}, x^{(k+1)}, \dots, x^{(n)}\right) = 0$, $f\left(x, x', \dots, x^{(n)}\right) = 0$, equations invariant under substitutions $x \to kx$ and $(t \to kt, x \to k^m x)$.

Homogeneous Linear ODEs: linearly dependent and independent solutions, fundamental system of solutions, Wronskian, Liouville's theorem, reduction of equation order using a known solution, finding solutions of form $e^{\lambda t}$, characteristic equation, cases of complex and repeated roots, Euler and Lagrange equations.

Nonhomogeneous Linear ODEs: decomposition into general and particular solutions, variation of parameters, integration of ODEs with specific right-hand sides using the method of undetermined parameters.

Systems of Linear ODEs: linearly dependent and independent solutions, fundamental system of solutions, finding solutions of form $\vec{c}e^{\lambda t}$, cases of complex and repeated roots, decomposition into general and particular solutions, variation of parameters, method of exclusion, method of integrable combinations, integration of systems with specific right-hand sides using the method of undetermined parameters.

Linear Differential Problems: initial-value, boundary-value and mixed problems, homogeneous and nonhomogeneous problems, Cauchy's function, Green's function, usage of Laplace transform to solve initial-value problems, Sturm-Liouville's problem (eigenvalues and eigenfunctions, spectrum of solutions, orthogonality of eigenfunctions, conditions of real and positive eigenvalues, spectrum decomposition theorem).

Approximate methods: dependence of the solution on initial conditions, method of iteration (small parameter), finding power series and general power series solutions.

Literature

1. A.F. Filippov. *Collection of problems on differential equations*. 2000 Izhevsk, 176 p, ISBN 5-93972-008-0.

Instructors

Associate Professor Oleksandr V. Romanenko.