Программа учебной дисциплины «Differential equations»

Утверждена
Академическим советом ООП
Протокол №___ от «30»июня 2016 г.

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Число кредитов	5
Контактная работа (час.)	76
Самостоятельная работа (час.)	114
Курс	2
Формат изучения дисциплины	Без использования онлайн курса

I. Syllabus

Learning Objectives:

1 Studing of basic technics of constructing of mathematical models defined by differential equations
2 Studying of some methods of the quality theory of differential equations
.3 Studying of basic methods of analytical solution of differential equation

Learning Outcomes: A student knows motivation and basic technics of constructing differ- ential equations in different tasks, basic methods of quality research and methods if finding exact solution of differential equations; is able to apply his knowledge to solution of textbook problems and confidently use a terminology of the subject.

II. Course Plan

4.1 Problems leading to differential equations. Methods of solution of the simplest first order differential equations.
4.2 The geometric interpretation of first-order equations.
4.3 Differential equations of higher orders.
4.4 Basic theorems.
4.5 Exact differential equations.
4.6 Linear equations of the first order.
4.7 Linear homogeneous equations with constant coefficients of order greater than one.

4.8 Classification of isolated singular points of autonomous systems of the second order.
4.9 Linear inhomogeneous equations with constant coefficients.
4.10 Introduction to the theory of stability.
4.11 Structural stability.
4.12 The simplest bifurcations in ODE systems. Saddle-node bifurcation, pitch-fork bifurcation, Andronov-Hopf bifurcation.
4.13 Stability by Lyapunov. The Lyapunov exponents.
4.14 Instability. Dynamical chaos. Examples of systems with chaotic dynamics.
4.15 Construction of Poincare map by ODE systems.
4.16 Classification of dynamic chaos: conservative (Hamiltonian chaos), strange attractors, mixed dynamics.
4.17 Main bifurcations of point maps: saddle-node, pitch-fork, period doubling, Neimark-Saker bifurcation.
4.18 Saddle limit cycles. Homoclinic structures.
4.19 Bifurcation analysis in the Henon map and the minimal Sprott map.
4.20 The main scenarios of the emergence of chaos in conservative and dissipative systems.

III. Grading system:

There are the following forms of control: current control of student activities on classes and homework, a written test at module 3 and an exam at the end of module 4. The cumulative current grade is comprised of: average grade for the activities on classes and home assignments (50%); written test (50%). The final grade is comprised of cumulative current grade (50%) and the grade for the exam (50%).

Assessment of knowledge is based on the results of written home and classroom tests. The result of inspection work is to assess, display on a 10-point scale in accordance with the following criteria:

• highest score 10 points is given for an original and correct solution of the task, that is with detailed explanations, calculations culture of problems and high-quality design work.

• estimate of 7-8-9 points exhibited in the presence of solutions of problems and correct aswer, but in the absence of any of the above distinctive features, for example, the detailed calculations and explana- tions or high-quality design.

• A score of 6 points is exposed in the presence of certain inaccuracies in the responses (including grammatical errors), or random errors of the arithmetic nature.

• A score of 5 points is exposed in cases where the answers and solutions to problems are contain in- accuracies and errors, indicating a lack of understanding and requiring additional studing of the sub- ject.

• A score of 4 points is exposed in the presence of serious errors and gaps in knowledge on the con-
trolled subjects.

• A score of 3 points is exposed in the presence of a single positive moments in the present study.

• A score of 2 is exposed in the absence of positive aspects in the present study.

• A score of 1 or 0 points exhibited when records does not contains right answers and solutions, in addition, accompanied by any demonstrative manifestations of ignorance or unethical attitude to study the subject and the object in general.

IV. EXAMPLES OF ASSESSMENT FACILITIES

1. Using the isoclines method to construct integral curves of the equation
   $y' = \frac{y \cos x}{1 + 2y^2}$
2. The bank opened an account for a certain amount. Find the dependence of the time for which the initial deposit will double, from the interest rate r. Assume that interest accrues continuously.
3. The natural population growth of a certain city is proportional to the number of inhabitants of this city and the period of time. In addition, the population of this city increases due to immigration, the rate of population growth in this way is proportional to the time measured from the moment when the population of the city was equal to A_0. Find the dependence of the number of inhabitants of this city on time.
4. Solve equation $4xy' + (4x+1)y^2 - 4y = 0$
5. Solve equation $(x - y + 1)dx + (x + y + 3)dy = 0$
6. Solve equation $(1 - 3x^2 - y)dx = (x - 3y^2)dy$
7. Does the equation $y''' + y = \cos t$ have periodic solutions? If the answer is yes, find them.

8. Resources

8.1 Reading list

1. Лерман, Л.М. Лекции по обыкновенным дифференциальным уравнениям: [учебник] / Л. М. Лерман. - М.; Ижевск: Институт компьютерных исследований, 2016. - 279 с. - (Университетские учебники и учебные пособия).
2. Муратова, Т.В. Дифференциальные уравнения [Электронный ресурс]: учебник и практикум для академического бакалавриата / Т.В.Муратова; ЭБС Юрайт. – М.: Юрайт, 2015. – 435 с. – Режим доступа: http://www.biblio-online.ru/thematic/?20&id=urait.content.BA3ABC9F-73F5-4204-87D2-663114257989&type=c_pub. – Загл. с экрана. Гриф УМО ВО

8.2 Optional literature

1. Пантелеев, А.В. Обыкновенные дифференциальные уравнения. Практический курс [Электронный ресурс]: учебное пособие с мультимедиа сопровождением / А.В.Пантелеев, А.С.Якимова, К.А.Рыбаков; ЭБС Znanium. – М.: Логос, 2010. - 384 с.: ил. - (Новая университетская библиотека). – Режим доступа: http://znanium.com/bookread.php?book=469288. – Загл. с экрана. Гриф УМО
2. Альсевич, Л.А. Дифференциальные уравнения. Практикум [Электронный ресурс]: учебное пособие / Л.А.Альсевич [и др.]; ЭБС Znanium. - Минск: Выш. шк., 2012. – 382 с. – Режим доступа: http://znanium.com/bookread.php?book=508479. – Загл. с экрана. Гриф МО РБ
3. Дифференциальные и разностные уравнения : учебное пособие / В. А. Калягин [и др.]. - Н. Новгород: Изд-во НГТУ, 2006. - 216 с.

8.3 Program software.

№ п/п	Наименование	Условия доступа
1.	MathWorks MATLAB	*Из внутренней сети университета (договор)*

8.4 Профессиональные базы данных, информационные справочные системы, интернет-ресурсы (электронные образовательные ресурсы)

№ п/п	Наименование	Условия доступа/скачивания
1	Электронные образовательные ресурсы	*Договор на использование электронных баз данных/по подключению и обеспечению доступа к базам данных*

8.5 Материально-техническое обеспечение дисциплины

Учебные аудитории для лекционных занятий по дисциплине обеспечивают использование и демонстрацию тематических иллюстраций, соответствующих программе дисциплины в составе:

– ПЭВМ с доступом в Интернет (операционная система, офисные программы, антивирусные программы);

– мультимедийный проектор с дистанционным управлением.

Учебные аудитории для лабораторных и самостоятельных занятий по дисциплине оснащены компьютером, с возможностью подключения к сети Интернет и доступом к электронной информационно-образовательной среде НИУ ВШЭ.