**MATH 219 Introduction to Differential Equations**

**Credit:** (4-0) 4

**Catalog description:** First order equations and various applications. Higher order linear differential equations. Power series solutions. The Laplace transform. Solutions of initial value problems. Systems of linear differential equations. Introduction to partial differential equations.

**Course Objectives:** By the end of this course, a student will:

* Classify and identify different types of differential equations,
* Explicitly solve several important classes of ordinary differential equations and interpret their qualitative behaviour,
* Apply ideas from linear algebra in order to solve single linear ordinary differential equations and systems of such equations,
* Model certain physical phenomena using differential equations and reinterpret their solutions physically,
* Use power series methods to solve second order linear differential equations
* Apply the Laplace transform for solving differential equations,
* Use the method of separation of variables in order to solve some basic partial differential equations via Fourier series.

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**Course Website:** <http://ma219.math.metu.edu.tr/> and <https://metuclass.metu.edu.tr/>

**Lectures:** All lectures of MATH 219 for the Fall 2020 semester will be asynchronous video lectures. These video lectures will be uploaded to METUClass before the lecture hours and can be accessed by the students at any time. For steady progress, students are recommended to watch and analyze the video lectures on the day of the lecture, at a time of their choice. Students are encouraged to contact the course instructors through online office hours and ask them questions about the material. The office hours of all instructors will be announced on the course webpage and on METUClass. Students are welcome to attend the office hours of the instructors of any section of the course. Typed lecture notes will also be provided through METUClass.

**Textbook:** “Elementary Differential Equations and Boundary Value Problems”, Boyce, W. E., DiPrima, R. C., 9th ed.

**Exams and Grading:** The grading will be based on 6 online short exams and one online oral exam.

* **Short Exams:** There will be 6 online short exams, to be conducted roughly once every two weeks, on weekends. Each of these will be worth 11% each (but see below). Each of these exams will have approximately 1 hour duration and will be conducted through METUClass. These exams will contain questions with short answers that can be entered via the METUClass system. Each short exam will test approximately the content of one chapter (see the weekly list of topics below). A reliable internet connection will be necessary during these exams.
* **Oral Exam:** Starting from Week 7 (November 23) and ending at the end of the Final Exams period (January 30) each student will once be invited to an oral exam. The exam times will be scheduled in advance (so that the exam most probably takes place during the lecture hours of the relevant section) and will be announced to the students. The oral exam will be worth 34% of the grade. The content of the oral exam will be all topics up to the end of the week before the oral exam is going to take place. Each student will be asked to answer one conceptual question and to solve one problem during the oral exam. A list of possible conceptual questions will be announced to the students who will take the exam in a given week one week before the exam date. During the oral exam, students are randomly assigned a conceptual question and a problem, and are allowed to work on their answers for 30 minutes with pencil and paper only, in an online exam room proctored through a webcam. Afterwards, the student meets his or her instructor and the course assistant online and explains the answers. The instructor will also ask several follow-up questions and may as well ask some others to better assess the student’s understanding of the material. This online meeting will take 15 minutes or less. A reliable internet connection and a webcam (or a smartphone with sufficient specifications) will be necessary during the oral exam.
* **Important Note:** If there is a serious mismatch in a student’s oral exam performance and the short exam performance, the weight of the oral exam in the assessment of the student’s letter grade will be significantly increased. More precisely, **if the oral exam grade (out of 100) of a student is less than half of the average grade of the same student on the short exams (out of 100 again), then the oral exam will be worth 67% of the total grade and the short exams will be worth 33% of the total grade.** Therefore it is of crucial importance for students to get well-prepared for the oral exam and to communicate their knowledge of the material in the clearest possible way.

**Suggested Problems**: A list of suggested problems will be announced on the course website. Students are encouraged to attempt to solve all of these problems in a timely manner, and ask the instructors about the ones that they cannot solve during online office hours.

**NA Policy:** A student who does not take the oral exam (or its make-up if applicable) will receive a grade of NA for the course.

**Make-up Policy:** In order to be eligible to enter a make-up examination for a missed examination, a student should have a documented or verifiable, and officially acceptable excuse. **A student who has an accepted excuse can get a make-up for at most 2 short exams or the oral exam but not both.** The make-up examinations for all exams will be after the final exam, and will include all topics.

**Lectures:**

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| --- | --- | --- |
| **Section, Instructor** | **Lecture Time and Place** | **Instructor e-mail,**  **Office (Math building), office phone** |
| S1. İbrahim Ünal | Tue 8:40-10:30  Thu 10:40-12:30 | [iunal@metu.edu.tr](mailto:iunal@metu.edu.tr)  241, (312) 210 5380 |
| S2. Hasan Taşeli | Tue 8:40-10:30  Thu 10:40-12:30 | [taseli@metu.edu.tr](mailto:taseli@metu.edu.tr)  221, (312) 210 2977 |
| S3. Hasan Taşeli | Tue 13:40-15:30  Fri 8:40-10:30 | [taseli@metu.edu.tr](mailto:taseli@metu.edu.tr)  221, (312) 210 2977 |
| S4. Kostyantyn Zheltukhin | Tue 13:40-15:30  Fri 8:40-10:30 | [zheltukh@metu.edu.tr](mailto:zheltukh@metu.edu.tr)  137, (312) 210 5385 |
| S5. İbrahim Ünal | Tue 13:40-15:30  Fri 8:40-10:30 | [iunal@metu.edu.tr](mailto:iunal@metu.edu.tr)  241, (312) 210 5380 |
| S6. Mohan Lal Bhupal | Tue 13:40-15:30  Fri 8:40-10:30 | [bhupal@metu.edu.tr](mailto:bhupal@metu.edu.tr)  236, (312) 210 5378 |
| S7. Özgür Kişisel | Tue 15:40-17:30  Thu 8:40-10:30 | [akisisel@metu.edu.tr](mailto:akisisel@metu.edu.tr)  128, (312) 210 5388 |
| S8. Ahmet İrfan Seven | Wed 15:40-17:30  Fri 10:40-12:30 | [aseven@metu.edu.tr](mailto:aseven@metu.edu.tr)  226, (312) 210 5391 |

**Online Office Hours:** To be announced on the website.

**Important Dates:**

* **October 12:** Classes begin
* **October 19-23:** Add-drop period
* **October 29:** Republic Day (Thursday)
* **October 31:** Short Exam 1 (Saturday)
* **November 10:** Commemoration of Atatürk (Tuesday)
* **November 21:** Short Exam 2 (Saturday)
* **December 5:** Short Exam 3 (Saturday)
* **December 14-20:** Course withdrawal applications
* **December 19:** Short Exam 4 (Saturday)
* **January 1:** New Year’s Day (Friday)
* **January 3:** Short Exam 5 (Sunday)
* **January 15:** Classes end
* **January 16:** Short Exam 6 (Saturday)
* **January 18-30:** Final Exam Period
* **February 8:** Grades announced

**Course Schedule:**

The table below is a rough guideline for the content of course lectures. Instructors may reorder their lectures as necessary/desired. Section and page numbers below are from the textbook, *Elementary Differential Equations and Boundary Value Problems*, Boyce and DiPrima, 9th ed., 2010.

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| --- | --- | --- |
| **Week 1:**  Oct.12-16 | 1 | **§1.1, §1.3:** Introduction, Direction Fields  **Chapter 2. First Order Differential Equations**  **§2.2:** Separable equations (also homogeneous equations - see p49 #30). |
| 2 | **§2.1:** Linear equations; Method of integrating factors. |
| **Week 2:**  Oct.19-23 | 3 | **§2.3:** Modeling with first order equations |
| 4 | **§2.4:** Differences between linear and nonlinear equations |
| **Week 3:**  Oct.26-30 | 5 | **§2.6:** Exact equations and integrating factors. |
| 6 | **Chapter 7. Systems of First Order Linear Equations**  **§7.1:** Introduction.  **§7.2:** Review of matrices. |
| **Week 4:**  Nov.2-6 | 7,8 | **§7.3:** Systems of linear algebraic equations; Linear independence, eigenvalues, eigenvectors. |
| **Week 5:** Nov.9-13 | 9 | **§7.4:** Basic theory of systems of first order linear equations.  **§7.5:** Homogeneous linear systems with constant coefficients. |
| 10 | **§7.6:** Complex eigenvalues. |
| **Week 6:**  Nov.16-20 | 11 | **§7.7:** Fundamental matrices.  **§7.8:** Repeated eigenvalues. |
| 12 | **§7.9:** Nonhomogeneous linear systems (variation of parameters only). |
| **Week 7:**  Nov.23-27 | 13 | **Chapter 4. Higher Order Linear Equations**  **§4.1:** General theory of *n*th order linear equations |
| 14 | **§4.2:** Homogeneous equations with constant coefficients. |
| **Week 8:**  Nov.30-Dec.4 | 15 | **§4.3:** The method of undetermined coefficients. |
| 16 | **§4.4:** The method of variation of parameters. |
| **Week 9:**  Dec.7-11 | 17 | **§3.7:** Mechanical and electrical vibrations.  **§3.8:** Forced Vibrations. |
| 18 | **Chapter 5. Series Solutions of Second Order Linear Equations**  **§5.1:** Review of Power Series  **§5.2:** Series Solutions Near an Ordinary Point, Part I  **§5.3:** Series Solutions Near an Ordinary Point, Part II |
| **Week 10:**  Dec.14-18 | 19 | **§5.4:** Euler Equations, Regular Singular Points |
| 20 | **§5.5:** Series Solutions Near a Regular Singular Point, Part I |
| **Week 11:**  Dec.21-25 | 21 | **Chapter 6. The Laplace Transform**  **§6.1:** Definition of the Laplace transform. |
| 22 | **§6.2:** Solution of initial value problems.  **§6.3:** Step functions. |
| **Week 12:**  Dec.28-Jan.1 | 23 | **§6.4:** Differential equations with discontinuous forcing functions. |
| 24 | **§6.5:** Impulse functions.  **§6.6:** The convolution integral. |
| **Week 13:**  Jan.4-8 | 25 | **Chapter 10. Partial Differential Equations and Fourier Series** **§10.1:** Two-point boundary value problems. |
| **Week 14:** Jan.11-15 | 26 | **§10.2:** Fourier series.  **§10.3:** The Fourier convergence theorem. |
| 27 | **§10.4:** Even and odd functions.  **§10.5:** Separation of variables, heat conduction in a rod. |