

# 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.

**Course Coordinator:** Özgür Kişisel (Office: 128, Mathematics Department. Phone: (312) 210 5388)  
[akisisel@metu.edu.tr](mailto:akisisel@metu.edu.tr)

**Course Assistant:** Rabia Gülşah Uysal (Office: Z-35, Mathematics Department. Phone: (312) 210 2994)  
[wwwma219@metu.edu.tr](mailto:wwwma219@metu.edu.tr)

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

**Textbook:** “Elementary Differential Equations and Boundary Value Problems”, Boyce, W. E., DiPrima, R. C., 10<sup>th</sup> ed.

**Office Hours:** To be announced.

**Exams and Grading:** The grading will be based on two midterm examinations and one final examination.

- **Midterm 1:** 30 % (18 November 2023, 17:00)
- **Midterm 2:** 30 % (23 December 2023, 17:00)
- **Final:** 40 % (date to be announced)

**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.

**NA Policy:** A student who misses all exams 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 cannot get make-up examinations for two missed exams. The make-up examination for all exams will be after the final exam, and will include all topics.

| Instructor   | Lecture Times and Places                           | Instructor e-mail,<br>Office (Math building), office phone                            |
|--|--|---|
| S1. Özgür Kişisel  | Tue 8:40-10:30 (YP-A1),<br>Thu 10:40-12:30 (YP-A3) | <a href="mailto:akisisel@metu.edu.tr">akisisel@metu.edu.tr</a><br>128, (312) 210 5388 |
| S2. Kostyantyn Zheltukhin  | Tue 8:40-10:30 (YP-A4),<br>Thu 10:40-12:30 (YP-A4) | <a href="mailto:zheltukh@metu.edu.tr">zheltukh@metu.edu.tr</a><br>137, (312) 210 5385 |
| S3. Mehmetçik Pamuk  | Tue 13:40-15:30 (U3)<br>Fri 8:40-10:30 (U3)        | <a href="mailto:mpamuk@metu.edu.tr">mpamuk@metu.edu.tr</a><br>124, (312) 210 2989     |
| S4. (students registered to section 4 should follow the course in section 5) |  |   |
| S5. Marat Akhmet   | Tue 13:40-15:30 (YP-A1)<br>Fri 8:40-10:30 (YP-A1)  | <a href="mailto:marat@metu.edu.tr">marat@metu.edu.tr</a><br>121, (312) 210 5355       |
| S6. (students registered to section 6 should follow the course in section 5) |  |   |
| S7. Semra Pamuk  | Tue 15:40-17:30 (U3)<br>Thu 8:40-10:30 (U3)        | <a href="mailto:pasemra@metu.edu.tr">pasemra@metu.edu.tr</a><br>228, (312) 210 2990   |
| S8. (students registered to section 8 should follow the course in section 9) |  |   |
| S9. Mohan Bhupal   | Wed 15:40-17:30 (YP-A2)<br>Fri 10:40-12:30 (YP-A1) | <a href="mailto:bhupal@metu.edu.tr">bhupal@metu.edu.tr</a><br>238, (312) 210 5378     |

### Important Dates:

- **October 2:** Classes begin
- **October 9-13:** Add-drop and advisor approvals
- **October 29:** Republic Day (Sunday)
- **November 10:** Commemoration of Atatürk (Friday)
- **December 4-10:** Course withdrawal applications
- **January 1:** New Year's Day (Monday)
- **January 5:** Last day of classes
- **January 8-20:** Final exam period
- **January 29:** The announcement of letter grades

### 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, 10<sup>th</sup> ed., 2010.

|                             |   |   |
|-----------------------------|---|---|
| <b>Week 1:</b><br>Oct.2-6   | 1 | §1.1, §1.3: Introduction, Direction Fields<br><b>Chapter 2. First Order Differential Equations</b><br>§2.2: Separable equations (also homogeneous equations - see p49 #30). |
|                             | 2 | §2.1: Linear equations; Method of integrating factors.  |
| <b>Week 2:</b><br>Oct.9-13  | 3 | §2.3: Modeling with first order equations   |
|                             | 4 | §2.4: Differences between linear and nonlinear equations  |
| <b>Week 3:</b><br>Oct.16-20 | 5 | §2.6: Exact equations and integrating factors.  |
|                             | 6 | <b>Chapter 7. Systems of First Order Linear Equations</b><br>§7.1: Introduction.<br>§7.2: Review of matrices.   |

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| <b>Week 4:</b><br>Oct.23-27    | 7,8 | <b>§7.3:</b> Systems of linear algebraic equations; Linear independence, eigenvalues, eigenvectors.  |
| <b>Week 5:</b><br>Oct.30-Nov.3 | 9   | <b>§7.4:</b> Basic theory of systems of first order linear equations.<br><b>§7.5:</b> Homogeneous linear systems with constant coefficients.                               |
|                                | 10  | <b>§7.6:</b> Complex eigenvalues.  |
| <b>Week 6:</b><br>Nov.6-10     | 11  | <b>§7.7:</b> Fundamental matrices.<br><b>§7.8:</b> Repeated eigenvalues.   |
|                                | 12  | <b>§7.9:</b> Nonhomogeneous linear systems (variation of parameters only).   |
| <b>Week 7:</b><br>Nov.13-17    | 13  | <b>Chapter 4. Higher Order Linear Equations</b><br><b>§4.1:</b> General theory of $n^{\text{th}}$ order linear equations   |
|                                | 14  | <b>§4.2:</b> Homogeneous equations with constant coefficients.   |
| <b>Week 8:</b><br>Nov.20-24    | 15  | <b>§4.3:</b> The method of undetermined coefficients.  |
|                                | 16  | <b>§4.4:</b> The method of variation of parameters.  |
| <b>Week 9:</b><br>Nov.27-Dec.1 | 17  | <b>§3.7:</b> Mechanical and electrical vibrations.<br><b>§3.8:</b> Forced Vibrations.  |
|                                | 18  | <b>Chapter 5. Series Solutions of Second Order Linear Equations</b><br><b>§5.1:</b> Review of Power Series<br><b>§5.2:</b> Series Solutions Near an Ordinary Point, Part I |
| <b>Week 10:</b><br>Dec.4-8     | 19  | <b>§5.3:</b> Series Solutions Near an Ordinary Point, Part II<br><b>§5.4:</b> Euler Equations, Regular Singular Points   |
|                                | 20  | <b>§5.5:</b> Series Solutions Near a Regular Singular Point, Part I  |
| <b>Week 11:</b><br>Dec.11-15   | 21  | <b>Chapter 6. The Laplace Transform</b><br><b>§6.1:</b> Definition of the Laplace transform.   |
|                                | 22  | <b>§6.2:</b> Solution of initial value problems.<br><b>§6.3:</b> Step functions.   |
| <b>Week 12:</b><br>Dec.18-22   | 23  | <b>§6.4:</b> Differential equations with discontinuous forcing functions.  |
|                                | 24  | <b>§6.5:</b> Impulse functions.<br><b>§6.6:</b> The convolution integral.  |
| <b>Week 13:</b><br>Dec.25-29   | 25  | <b>Chapter 10. Partial Differential Equations and Fourier Series</b><br><b>§10.1:</b> Two-point boundary value problems.   |
|                                | 26  | <b>§10.2:</b> Fourier series.  |
| <b>Week 14:</b><br>Jan.1-5     | 27  | <b>§10.3:</b> The Fourier convergence theorem.<br><b>§10.4:</b> Even and odd functions.  |
|                                | 28  | <b>§10.5:</b> Separation of variables, heat conduction in a rod.   |