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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Contact: You may contact course coordinator in case of necessities. For inquires you can e-mail to 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^{th} ed.

Lectures: All lectures of MATH 219 for the Spring 2022 semester will be face-to-face lectures.

Office Hours: To be announced.

Exams and Grading: The grading will be based on two midterm exams and one final exam. All exams will be in class exams.

- **Midterm 1:** 30 % (date: 16.04.2022, Saturday at 17:30)
- **Midterm 2:** 30 % (date: 04.06.2022, Saturday at 17:30)
- **Final:** 40 % (date: 22.06.2022, Wednesday at 17:00)

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, Office (Math building), office phone**
S1. Özgür Kişisel	Tue 10:40-12:30 (U3), Fri 8:40-10:30 (U3)	akisisel@metu.edu.tr 128, (312) 210 5388
S2. Ahmet Beyaz	Mon 10:40-12:30 (YP-A3), Thu 8:40-10:30 (YP-A3)	beyaz@metu.edu.tr 123, (312) 210 5381

Important Dates:

- **March 7:** Classes begin
- **March 14-18:** Add-drop period
- **April 16:** Midterm 1 (Saturday)
- **April 23:** National Sovereignty and Children's Day (Saturday)
- **May 1:** Labor and Solidarity Day (Sunday)
- **May 2-4:** Religious Holiday (Monday-Wednesday)
- **May 9-15:** Course withdrawal applications
- **May 19:** Commemoration of Atatürk & Youth and Sports Festival (Thursday)
- **June 4:** Midterm 2 (Saturday)
- **June 17:** Last day of classes
- **June 20-July 2:** Final Exam Period
- **July 13:** 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, 10th ed., 2010.

Week 1: Mar.7-11	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: Mar.14-18	3	**§2.3:** Modeling with first order equations
	4	**§2.4:** Differences between linear and nonlinear equations
Week 3: Mar.21-25	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: Mar.28-Apr.1	7,8	**§7.3:** Systems of linear algebraic equations; Linear independence, eigenvalues, eigenvectors.
Week 5: Apr.4-8	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: Apr.11-15	11	**§7.7:** Fundamental matrices. **§7.8:** Repeated eigenvalues.

	12	**§7.9:** Nonhomogeneous linear systems (variation of parameters only).
Week 7: Apr.18-22	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: Apr.25-29	15	**§4.3:** The method of undetermined coefficients.
	16	**§4.4:** The method of variation of parameters.
Week 9: May.2-6	17	**§3.7:** Mechanical and electrical vibrations. **§3.8:** Forced Vibrations.
Week 10: May.9-13	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
	19	**§5.3:** Series Solutions Near an Ordinary Point, Part II **§5.4:** Euler Equations, Regular Singular Points
Week 11: May.16-20	20	**§5.5:** Series Solutions Near a Regular Singular Point, Part I
Week 12: May.23-27	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 13: May.30-Jun.3	23	**§6.4:** Differential equations with discontinuous forcing functions.
	24	**§6.5:** Impulse functions. **§6.6:** The convolution integral.
Week 14: Jun.6-10	25	**Chapter 10. Partial Differential Equations and Fourier Series** **§10.1:** Two-point boundary value problems.
	26	**§10.2:** Fourier series.
Week 15: Jun.13-17	27	**§10.3:** The Fourier convergence theorem. **§10.4:** Even and odd functions.
	28	**§10.5:** Separation of variables, heat conduction in a rod.