



## MIDDLE EAST TECHNICAL UNIVERSITY

2022-2023 Fall Semester

### PHYS 209 Mathematical Methods in Physics I

- **Instructor** Prof. Dr. İsmail RAFATOV email: [rafatov@metu.edu.tr](mailto:rafatov@metu.edu.tr)  
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- **Class hours and Place** **Wed.** 10:40 – 12:30 (U1) **Fri.** 10:40 – 12:30 (U1)

#### Course Description

##### Course Content:

- Ordinary differential equations;
- Boundary value problems for 2<sup>nd</sup> order linear ordinary differential equations and Sturm-Liouville theory;
- Fourier series;
- Partial differential equations and the method of separation of variables.
- Systems of 1<sup>st</sup> order linear differential equations.

Course Objectives: This course aims to provide students with the mathematical tools necessary to solve physical problems expressed in the form of differential equations, with particular emphasis on methods for solving initial and boundary value problems for ordinary differential equations, Fourier series, and the method of separation of variables for basic partial differential equations.

Learning Outcomes: By the end of the semester, students should be able to classify and solve linear homogeneous and nonhomogeneous ordinary differential equations of the first, second, and higher order, as well as systems of linear differential equations of the first order, partial differential equations of mathematical physics, and to use the Fourier series method in the relevant problems.

**Instructional Methods:** In class lectures.

**Grading:** The term grades will be determined from two midterm exams (30%+30%) and final exam (40%).

##### **Course Policies and Requirements:**

- Attendance of all classes on a regular basis is required. Attendance is taken in each class.
- A student who misses two of three exams receives an NA grade for the course.
- To be eligible to take a make-up exam for a missed exam, a student must have a documented or verifiable and officially acceptable excuse. A student can only take one make-up exam for missed exams. The make-up is scheduled after the final exam and includes all topics covered by the course.
- Self-study homework assignments are handed out during the semester. The students are encouraged to work together and discuss problems with each other, however, the solutions must be worked out individually.

##### **Course Textbook**

- Boyce WE and DiPrima RC, Elementary Differential Equations and Boundary Value Problems (10<sup>th</sup> Ed.), NY: J. Wiley (2012)

## Course Plan:

Week	Topic	Reading (Boyce & DiPrima 10th Ed.)
1-2	Definition and classification of differential equations. 1 <sup>st</sup> order ordinary differential equations (Exact equations and integrating factors; Separable equations; Homogeneous equations; Linear equations; Bernoulli equations). The existence and uniqueness theorem. Some applications of 1 <sup>st</sup> order equations.	Ch. 1.1 – 1.3, 2.1 – 2.8
3	2 <sup>nd</sup> and higher order linear differential equations. Homogeneous equations. Linear Independence of solutions and Wronskian. Reduction of order.	3.1 - 3.2, 4.1
4	Homogeneous equations with constant coefficients. Nonhomogeneous equations. The method of undetermined coefficients.	3.3 - 3.5, 4.2 - 4.3
5	The method of variation of parameters. Cauchy-Euler equation. Some applications of 2 <sup>nd</sup> order linear differential equations. Mechanical vibrations.	3.6 - 3.8, 4.4
6-7	Series solutions of 2 <sup>nd</sup> order linear differential equations. Solutions near an ordinary point. Solutions near a regular singular point. Frobenius method.	5.1 - 5.6
8-9	Boundary value problems and Sturm-Liouville theory. Eigenvalues and eigenfunctions. Eigenfunction representations.	11.1 - 11.2
10	Fourier series. Fourier sine and cosine series. Fourier convergence theorem.	10.1 - 10.4
11-12	Partial differential equations and the methods of separation of variables. Wave equation. Heat equation. Laplace's equation.	10.5 - 10.8
13-14	Systems of first order linear differential equations. Basic theory of systems of 1 <sup>st</sup> order linear equations. Homogeneous linear systems with constant coefficients.	7.1 - 7.7

## Supplementary Readings

- Boas ML, Mathematical Methods in the Physical Sciences, NY: John Wiley (2006)
- S.L. Ross, Differential Equations, 3rd Edition, Wiley (1984)
- R. Haberman, Elementary Applied Partial Differential Equations : with Fourier series and boundary value problems, Pearson (2012)
- Hildebrand FB, Advanced Calculus for Applications, Prentice-Hall Inc. (1976)

## Course Materials:

- Lecture Notes
- Video/audio materials / screen recordings

are provided through the ODTUClass webpage of the course.

## Exam Dates and Places:

1 <sup>st</sup> midterm exam:	November 07, 2022	(Monday)	17:40
2 <sup>nd</sup> midterm exam:	December 12, 2022	(Monday)	17:40
Final exam:	TBA		