FIRST COURSE HANDOUT

MTH421: ORDINARY DIFFERENTIAL EQUATIONS

Instructor: Dr. Vikramjeet Singh Chandel
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Lecture Schedule: Monday, Tuesday, Thursday: 15:00–16:00
Lecture Venue: L-16
Tutorial: Friday: 15:00 pm – 16:00, L-16.
Course Webpage: https://sites.google.com/view/vikramjeet-chandel/teaching

Objectives

Ordinary differential equations (ODEs) serve as mathematical models for a wide variety of real-life phenomena—not only in science and engineering, but also in fields as diverse as economics, psychology, defence, and demography. The rapid development of ODE theory and its applications across disciplines continues to fuel student interest in this subject. This course aims to build a solid understanding of the fundamentals of differential equations, with particular emphasis on their applications, limitations, and theoretical underpinnings. Several classical techniques for solving differential equations of various orders and degrees will be introduced and analysed. However, it is important to recognize the inherent limitations of these methods: many seemingly simple differential equations do not admit closed-form solutions in terms of elementary functions. Hence, a major focus of this course will be on identifying the conditions under which a given differential equation has a unique solution. We will study the qualitative behavior of solutions, systems of differential equations, and the stability theory for linear systems. The course will also cover Sturm–Liouville boundary value problems, oscillation theory, and Green's functions. By the end of the course, students will have acquired a foundational exposure to dynamical systems and the mathematical tools used to analyse them.

Syllabus

- Introduction to ODE; Existence and uniqueness of solution; Continuity and differentiability of solution w.r.t. initial condition and parameters
- First order equations and their applications
- Higher order equations and their applications
- Power series solution of linear differential equations
- Linear equations with periodic coefficients
- System of linear differential equations; Stability theory for system of linear differential equations

Date: Semester: August–December, 2025 (Odd).

- Sturm-Liouville boundary value problems, Oscillation theory, Green's function

References

1. G. Teschl, *Ordinary Differential Equations and Dynamical Systems*, Graduate Studies in Mathematics, American Mathematical Society.
   This is going to be the primary text for this course. This book is available online. For exercises, you may consult the following books too.
2. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, CRC Press, 2017
3. M. Braun, *Differential Equations and Their Applications*, Springer, 1992
4. S. L. Ross, *Introduction to Ordinary Differential Equations*, Wiley, 1980
5. E. A. Coddington and N. Levinson, *Theory of Differential Equations*, Tata McGraw Hill, 1972

Examinations

- **Mid and End semester exams:** One mid-semester exam and one end-semester exam, contributing 30% and 50% respectively.
- **Quizzes:** 2 in-lecture quizzes, contributing a total of 20%.

Assignments

- **Theoretical:** Assignments will be sent via email.

Grading Policies

- Mid-semester: 30%
- End-semester: 50%
- Quizzes: 20%

Note: No makeup quizzes, lab exams, or mid-semester exams will be given irrespective of the reason for absence.

Academic Honesty

Students may collaborate on assignments, but no collaboration is allowed during quizzes or exams. Any dishonest practice during assessments will be reported to DOAA and appropriate action will be taken.