East China Normal University
GEC International Summer School

MAT27: Introduction to Differential Equations

Term: June 16th to July 18th, 2025
Class Hours: Monday through Friday, 110 minutes each day (2,750 minutes in total)
Instructor: Peiyuan Huang
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Course Description

Differential Equations are the language in which the laws of nature are expressed. Understanding properties of solutions of differential equations is fundamental to mathematical modeling, physics and engineering. This course focuses on linear differential equations and their applications in science and engineering.
Prerequisite: MAT12 Calculus 2 and MAT21 Linear Algebra.

Course Overview

Model simple systems to obtain ODEs. Visualize solutions using direction fields and isoclines, and approximate them using Euler's method. Solve a first order linear ODE by the method of integrating factors or variation of parameter. Solve a constant coefficient second order linear initial value problem. Compute Fourier coefficients, and find periodic solutions of linear ODEs by means of Fourier series. Delta functions and convolution integral. Solve constant coefficient linear initial value problems using the Laplace transform together with tables of standard values. Solve first order linear systems and relate first order systems with higher-order ODEs.

Learning Objective

This course is a study of Ordinary Differential Equations (ODE's), including modeling physical systems.

Topics include:

- Solution of First-order ODE's by Analytical, Graphical and Numerical Methods;
- Linear ODE's, Especially Second Order with Constant Coefficients;
- Undetermined Coefficients and Variation of Parameters;
- Higher order ODE and System;
- Sinusoidal and Exponential Signals: Oscillations, Damping, Resonance;
- Fourier Series, Periodic Solutions;
- Delta Functions, Convolution, and Laplace Transform Methods;

Required Text

The only textbook required is **Elementary Differential Equations and Boundary Value Problems**, 11th Edition; by William E. Boyce, Richard C. DiPrima, Douglas B. Meade.

Print ISBN: 978-1-119-37792-4

Course Hours

The course has 25 class sessions in total. Each class session is 110 minutes in length, for a total of 2750 minutes of in-class time. The course meets from Monday to Friday. ECNU awards 3 credits for this course. Different universities may count course credits differently. Consult officials at your own home institution.

Attendance

Summer school is very intense and to be successful, students need to attend *every class*. Occasionally, due to illness or other unavoidable circumstance, a student may need to missa class. ECNU policy requires a medical certificate to be excused. Any absence may impact on the student's grade. Moreover, ECNU policy is that a student who has more than 3 absences will fail the course. Arriving late or leaving early will count as a partial absence.

Grading Policy

ECNU awards grades of A, A-, B+, B, B-, C+,C,D, and F. Most colleges and universities do not award transfer credit for grades of D or F.

In this course, grading will be based on the following:

Assignments*5	5%*5=25%
Midterm Exam	35%
Final Exam	40%

General Expectations

Students are expected to:

- Attend all classes and be responsible for all material covered in class and otherwise assigned. Anyunexcused absence may impact a student's grade.
- Arrive to class on-time: Late arrivals are disruptive to your fellow students and to the conduct of the class.
- Complete the day's required reading and assignments before class
- Review the previous day's notes before class; make notes about questions you have about the previous class or the day's reading
- Refrain from texting, phoning or engaging in computer activities unrelated to class during class (不要用手机) It is highly disrespectful to the professor and to the class.
- Participate in class discussions and complete required written work on time.

Course Schedule

The planned schedule sketched out below maybe modified to suit the interests or abilities of the enrolled students or to take advantage of special opportunities or events that may arise during the term.

Week 1

- *Day 1*
  - *Introduction offirst order ODE*
  - *Directionfields and isoclines*
- *Day 2*
  - *Euler's method*
  - *Separable ODEs. Modeling*
- *Day 3*
  - *Exact ODEs. Integrating Factors*
  - *Linear ODEs. Bernoulli Equation. Population Dynamics*
  - *Existence and Uniqueness ofSolutionsfor Initial Value Problems*
- *Day 4*

  - *Homogeneous Linear ODEs ofSecond Order*
  - *Homogeneous Linear ODEs with Constant Coefficients*
  - *Differential Operators*
- *Day 5*
  - *In-class exercises*
  - *Assignment 1 due*

Week 2

- *Day 1*
  - *Modeling ofFree Oscillations ofa Mass–Spring System.*
- *Day 2*
  - *Euler–Cauchy Equations*
  - *Existence and Uniqueness ofSolutions (Wronskian)*
- *Day 3*
  - *Nonhomogeneous ODEs*
- *Day 4*
  - *Modeling: Forced Oscillations. Resonance*
- *Day 5*
  - *Modeling: Electric Circuits*
  - *Solution by Variation ofParameters*

Week 3

- *Day 1*
  - *Higher Order Homogeneous Linear ODEs*
- *Day 2*
  - *Nonhomogeneous Linear ODEs*
- *Day 3*
  - *Midterm*
- *Day 4*
  - *Systems ofODEs. Phase Plane*
  - *Basic Theory ofSystems ofODEs (Wronskian)*
- *Day 5*
  - *Constant-Coefficient Systems. Phase Plane Method*

Week 4

- *Day 1*
  - *Fourier Series, Series Solutions ofODEs*
  - *Power Series Method*

  - *Frobenius Method*
- *Day 2*
  - *Bessel's Equation.*
- *Day 3*
  - *Laplace Transform, Transforms ofDerivatives and Integrals*
  - *First Shifting Theorem*
- *Day 4*
  - *Unit Step Function (Heaviside Function).*
  - *Second Shifting Theorem*
- *Day 5*
  - *In-class exercises*
  - *Assignment 4 due*

Week 5

- *Day 1*
  - *Convolution. Integral Equations*
- *Day 2*
  - *Differentiation and Integration of Transforms.*
  - *Laplace Transform: General Formulas*
- *Day 3*
  - *Final review session*
- *Day 4*
  - *Final review session*
- *Day 5*
  - *Finalexam*
  - *Assignment 5 due*

Academic Honesty

Students are expected to maintain high standards of academic honesty. Specifically, unless otherwise directed by the professor, students may not consult other students, books, notes, electronic devices or any other source, on examinations. Failure to abide by this may result in a zero on the examination, or even failure in the course.