Columbia University

MATH S3027
Summer 2020 session 2
Ordinary Differential Equations
Course Overview

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OVERVIEW

This is a tentative course structure outline and is subject to change

Document updated April 17, 2020

THE COURSE

This course is an introduction to ordinary differential equations (ODE). It covers techniques for solving a variety of classes of ODEs, with a focus to find explicit solutions whenever possible. We will take on a journey learning different techniques and tricks. Student familiar with working out integrals may find certain parallel in this learning experience.

This course is designed to be both theoretical and practical. Students are challenged in the following aspects:

- Theoretical
  - Theorems, proofs (and how to write a coherent proof)
  - Geometric and algebraic intuitions
  - Imagining algorithms, process and its outcome
- Practical
  - Concrete calculations, results interpretations

This course is particularly interesting for those who want to acquire an understanding of the abstract theory as well its practical applications in different areas with a balance fine-tuned based on the class backgrounds compositions. If you like working out definite indefinite integrals, you may like also solving ODEs.

PRE-REQUISITES

Familiarity with differential and integral calculus: derivatives of functions (e.g. trigonometric, exponential, natural log). Ability to compute standard integrals with various techniques (e.g. integration by parts, change of variables). Working knowledge with complex number (e.g. solving a quadratic equation with a negative determinant) and linear algebra (matrix multiplication, linear transformations, determinants, eigenvectors and eigenvalues)

WHO IS IT FOR?

If you intend to learn serious science or engineering subjects (e.g. Physics, Chemistry, Social Sciences, Mathematics) you will come across ODE at some point. This class sharpens your intuition and enable you to formulate and solve problems in a variety of disciplines.

TEXTBOOKS

	Name	Author(s)	Details	Comments
1	Elementary Differential Equations and Boundary Value Problems, 10th Edition	Boyce and DiPrima.	ISBN 10: 0470458313 ISBN-13: 978-0470458310 Publisher: Wiley; 10 edition (2012)	Required (this is the edition the department has decided to use)
2	Elementary Differential Equations and Boundary Value Problems, 11th Edition	Boyce and DiPrima.	ISBN-10: 1119443768 ISBN-13: 978-1119443766 Publisher: Wiley; 11 edition (August 21, 2017)	Optional. You may need to get access (e.g. math library) to get the correct homework problem sets

There will be homework problems assigned based on the textbook above. It would be a good idea to buy / borrow a copy so you have ready access. Sometimes Columbia

University Mathematical Library has copies placed on reserve shelf. You may be able to check out a copy.

COURSE CONTENTS

We intend to follow closely the textbook with some omissions of non-essential sections, and adding some topics if time permits.

Topics to cover: we will roughly follow chapters 1 to 7 of the textbook by Boyce and DiPrima

- First order ODEs (linear, separable, exact)
- Second order and higher order ODEs with constant coefficients
- Non-homogeneities ODEs (variation of parameters, the method of undetermined coefficients)
- Second order linear ODEs and series solutions
- Laplace transform if time permits
- Systems of first order linear ODEs

Since it is a feature that summer session is very fast pace and condense, topics may be subtracted depends on actual class composition.

Pace is very tentatively planned as below

Week 1: First order ODE (separable, integrating factor technique)

Week 2: First order ODE (homogeneous); Second order homogeneous ODEs with constant coefficients. Wronskian. Complex roots of the characteristic equation

Week 3: Repeated roots, reduction of order. Non-homogeneous ODEs with constant coefficients. Method of undetermined coefficients. Variation of parameters. Midterm

Week 4: Higher order homogeneous ODEs with constant coefficients. Method of undetermined coefficients. Variation of parameters. Power series. Ordinary versus singular points. Series solution near ordinary point.

Week 5: Regular versus irregular singular points. Series solution near regular singular point.

Week 6: Laplace transform / Systems of first order linear ODEs. Final exam.

REQUIRED WORK

Students are required to complete homework assignments.

There will be midterm and final exams. Classroom participation and other factors will also contribute to the final grade. The exact proportions will be determined when class begins.

GRADING

We will determine the percentage contribution of homework, midterm, final exam, class participation towards the final grade when class begins

GRADING POLICY

INTEGRITY

All solutions to the homework, test and exams (take home or otherwise) should be your work. Academic common sense should provide a good guideline and if you are in doubt please consult the instructor. A substantiated violation of the code of integrity and/or academic dishonesty (homework copying for example) may result in serious academic disciplinary action (including but not limited to a failing grade of this course)

LATE POLICY

Late assignment receives no points. If you still want to hand it in, it should be given directly to the TA.

Late or omitted assignments due to exceptional circumstances (e.g. serious illness with doctor's note or emergency) would be handled on a case-by-case basis.

DISABILITY-RELATED ACADEMIC ACCOMMODATIONS

In order to receive disability-related academic accommodations for this course, students must first be registered with their school Disability Services (DS) office. Detailed information is available online for both the Columbia and Barnard registration processes.

Refer to the appropriate website for information regarding deadlines, disability documentation requirements, and drop-in hours(Columbia)/intake session (Barnard).

For this course, students are not required to have testing forms or accommodation letters signed by faculty. However, students must do the following:

- The Instructor section of the form has already been completed and does not need to be signed by the professor.
- The student must complete the Student section of the form and submit the form to Disability Services.
- Master forms are available in the Disability Services office or online: https://health.columbia.edu/services/testing-accommodations

For further information concerning Disability Services, please contact

Disability Services, Columbia Health

Wien Hall, 1st Floor Suite 108A, 411 W. 116th Street, MC 3714, New York, NY 10027

Phone: 212.854.2388

www.health.columbia.edu/ods

ABOUT THE INSTRUCTOR

Tat Sang Fung holds a Ph.D. in Mathematics from Columbia University in the City of New York (1996). He has taught Differential Equations and Numerical Methods, Advanced Calculus, Linear Algebra, Basic Mathematics, College Algebra and Analytic Geometry. He coauthored the article "BGM numeraire alignment at will" published in Risk International, 2004. He has over 23 years of experience in mathematical finance specializing in financial engineering and quantitative techniques in Treasury and Capital Markets.

Tat Sang Fung has been teaching graduate level classes at Columbia since Spring 2006. He can be reached at fts@math.columbia.edu

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