350 Introduction to Differential Equations

Princeton
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Spring Term, 11/12

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Course Overview & Philosophy

Whether you are interested in applied mathematics, engineering, or the natural sciences, a strong foundation in differential equations will imbue you with a better understanding of the physical world. This course will introduce you to the basic theory and applications of ordinary and partial differential equations. It differs from other similar courses (*e.g.* MAT301 and MAT303) by striking a balance between theoretical issues (*e.g.* existence and uniqueness) and applied issues (*e.g.* numerical or analytical approximations). The main objective of this course is to provide you with an understanding and appreciation for both approaches.

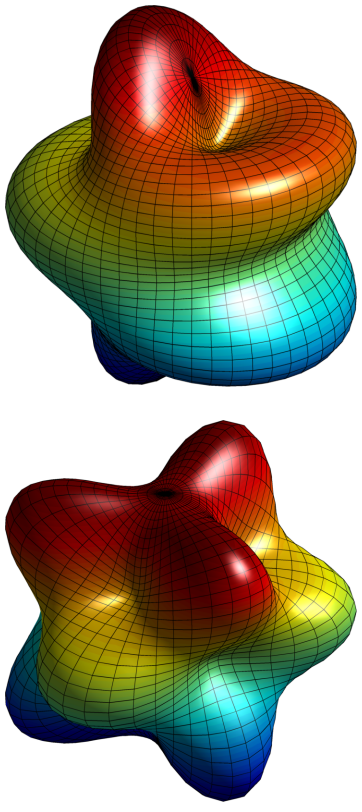
Tentative Lecture Plan

Part 1. Ordinary Differential Equations

1 History of ordinary differential equations (ODEs)
2 First-order ODEs
3 Second-order ODEs
4 Second-order ODEs
5 Inhomogeneous and miscellaneous ODEs
6 Systems of ODEs
7 Qualitative methods
8 Euler's method and integral formulation
9 Existence & uniqueness
10 Series solutions
11 Series solutions
12 Series solutions

Part 2. Partial Differential Equations

13 History of partial differential equations (PDEs)
14 Method of characteristics.
15 Shocks, nonlinear PDEs, and Charpit's method
16 Separation of variables.
17 Separation of variables.
18 Bessel functions & Legendre polynomials
19 Greens functions
20 Greens functions
21 Complex numbers & Laplace transforms
22 Fourier transforms
23 Singular asymptotics
24 Singular asymptotics



These surfaces are solutions of a partial differential equation known as Laplace's equation. In the same way that sound waves are broken down into sines and cosines, these *spherical modes* can be used to describe vibrations of a sphere.

Matlab

In order to help us study differential equations, we will learn some of the basics of using Matlab, a numerical software and language well suited for scientific computation. You are encouraged to download a copy here: www.princeton.edu/software/licenses/software/matlab/

Notes and resources

Typeset notes are being prepared during the term, and the hope is that the notes for each particular lecture will be available *the day of*. In general, we won't follow any one particular book, but here are some good references:

Boyce & DiPrima, *Elementary Differential Equations & Boundary Value Problems*: A famous and very good introduction to differential equations for new learners. Lots of problems and lots of examples.

P. Collins, *Differential and Integral Equations*: A succinct book on some of the 'advanced' topics we cover (less mechanical than the above reference). This book should be available for online access via the library.

A. Jeffrey, *Applied Partial Differential Equations: An Introduction*: This is one of the few textbooks that teaches partial differential equations from an applied mathematical standpoint (versus a pure or an overly computational and mechanical standpoint).

S. tHowison, *Practical Applied Mathematics*: This book is not meant as a comprehensive textbook to learn from, but is written in a friendly, intuitive manner, and may give you more insight into topics on ordinary and partial differential equations from an applied perspective.

Evaluation

Your mark will be split between six problem sets (50%) and the final exam (50%).

Problem sets

Problem sets will be handed out every two weeks at the end of class, and are due in one week's time at the *beginning* of class. They will be handed out every Wednesday during:

Week 2 – Feb. 15
Week 4 – Feb. 29
Week 6 – Mar. 14
Week 8 – Apr. 04
Week 10 – Apr. 18
Week 12 – May. 02

Note that the week of spring break (Mar. 19–23) does not count as a 'week' above, so the third assignment is handed-in during the week following the break.