

Mathematics 215/255

Elementary Differential Equations I

September-December, 2016W

- Instructors:
- Section 101 (Rahmani)
- Section 102 (Froese)
- Section 103 (Yang)
- Section 104 (Daskalakis)

Textbook:

We will use the free online text

Diffy Qs: Differential equations for Engineers, by Jiri Lebl, available at
<http://www.jirka.org/diffyqs/diffyqs.pdf>.

You may also consult

Differential Equations and their Applications, by Martin Braun, available as an e-book at the UBC library.
Elementary differential equations and boundary value problems, by Boyce and DiPrima, used as a text for this course in previous years.

Topics (relevant sections in text):

PART 0: Introduction

1. Introduction, examples and terminology: ODE vs PDE, linear vs non-linear, order, general and particular solutions. (0.2)

PART I: First order ODE's: $y'=f(x,y)$

2. Solutions using integrals for $f(x,y)=f(x)$, $f(x,y)=f(y)$ (1.1)

3. Separable equations: $f(x,y)=f(x)g(y)$, examples showing non-uniqueness and blowup. (1.3)

4. Slope fields, existence and uniqueness theorem. (1.2)

5. First order linear equations: $y'+p(x)y=q(x)$, integrating factor, formula for solution, mixing problem. (1.4)

6. Bernoulli eqns: $y'+p(x)y=q(x)y^n$, examples (1.5)

7. Homogeneous eqns: $y'=F(y/x)$, examples, headlight switching

8. Qualitative theory for $y'=f(y)$ (autonomous eqns) (1.6)

9. Euler method for numerical solutions. (1.7)

PART 2: Second order linear ODE's: $y''+p(x)y'+q(x)y=f(x)$

10. Existence and uniqueness, operator notation $Ly=f$, structure of the solution set. (2.1)

11. Homogeneous case ($f=0$): subspace property, linear independence and the Wronskian

12. Constant coefficients. (2.1)

13. Complex roots (2.2.1, 2.2.2)
14. Amplitude and phase shift form of solution, higher order equations, finding a particular solution (2.3, 2.5.1)
15. Method of undetermined coefficients (guessing)
16. Mass-spring system, forced oscillations (2.4.1, 2.6)
17. Reduction of order, variation of parameters. (2.5.3)

PART 3: The Laplace Transform

18. Laplace transform, definition, key properties, examples (6.1)
19. Laplace transform ctd. (6.2)
20. Constant coef. initial value problems using Laplace transforms.
21. Convolutions (6.3)
22. Delta functions (6.4)

PART 4: Linear Systems of ODE's

23. Systems of ODE's, first order linear systems (3.1)
24. Homogeneous constant coef systems: real eigenvalues (3.4)
25. Complex eigenvalues
26. Trajectories for complex eigenvalues, repeated eigenvalues. (3.7)
27. Inhomogeneous systems.
28. Inhomogeneous system, ctd.

PART 5: Non-linear Systems of ODE's

29. Linearization about fixed points, defn of stability. (8.1)
30. Stability of non-linear fixed points (8.2)
31. Conservative systems, pendulum (8.3)
32. Predator-prey models, nullclines
33. Competing species

Homework and Tests:

There will be weekly homework assignments consisting of webwork questions and written questions. The written questions are to be handed in at the beginning of class on the due date. Assignments and due dates will be posted below. You may discuss the homework problems with your fellow students, but the write up must be your own work.

There will be two in-class midterm exams. The dates will be posted on the web page for your section (see the links below) There will be no make-up midterms. If you miss a midterm for a valid medical reason, the weighting for the final will be adjusted. Other than this, no re-negotiating of the weights of the different components of the overall grade will be considered.

There will be a common final exam written during the exam period on December.

Grades:

Final Exam: 50%,
2 Midterms: 18% each
Webwork homework: 5%,
Written homework: 9%.