UBC MATH 215/255 (3 Credits)
Elementary Differential Equations I / Ordinary Differential Equations

Text

Lebl, *Notes on Diffy Qs*, version 5.4, 11 Oct 2018.

Purpose

This course is an introduction to ordinary differential equations (ODEs) and models that involve ODEs in several areas of application including physics, chemistry, biology, ecology, and engineering.

Pre-requisites and Co-requisites

Pre-requisites: MATH 101 (calculus) or equivalent, and MATH 221 or 152 (linear algebra) or equivalent.
Co-requisite: MATH 200 or 253 (multivariable calculus) or equivalent.

Schedule of lectures (subject to change):

1 Wed Jan 02: 1.2 (slope fields/existence-uniqueness), 1.3, 1.4
2 Fri Jan 04: 1.2, 1.3 (separable equ), 1.4
3 Mon Jan 07: 1.2, 1.3, 1.4 (linear equ/integrating factor)
4 Wed Jan 09: 1.5 (Bernoulli equ, homogeneous equ)
5 Fri Jan 11: 1.6 (autonomous equ, phase portrait)
6 Mon Jan 14: 1.7 (Euler's method)
7 Wed Jan 16: 2.1 (minimal theory of 2nd order linear equ, NO Wronskian), 2.2
8 Fri Jan 18: 2.2 (constant coeff 2nd order liner, real roots distinct and repeated or "doubled" in textbook)
9 Mon Jan 21: 2.2 (complex roots)
10 Wed Jan 23: 2.4 (mass and spring without and with damping)
11 Fri Jan 25: 2.4
12 Mon Jan 28: 2.5 (undetrmined coeff, var of param)
13 Wed Jan 30: 2.5
14 Fri Feb 01: 2.6 (forced oscillations, resonance)
15 Mon Feb 04: 2.6
16 Wed Feb 06: 3.1 (systems: especially relation to 2nd order equ, vector/direction field)
17 Fri Feb 08: Midterm Test 1 on Chapters 1, 2
18 Mon Feb 11: 3.3 (linear systems of ODEs) (skip 3.2, it is prerequisite))
19 Wed Feb 13: 3.4 (Eigenvalue method – distinct real, complex)
20 Fri Feb 15: 3.4

Midterm break
21 Mon Feb 25: 3.5 (2D phase portraits for linear systems)
22 Wed Feb 27: 3.6 (multiple eigenvalues)
23 Fri Mar 1: 8.1 (Nonlinear systems: critical points, linearization)
24 Mon Mar 4: 8.2 (stability, classification)

Sections (Hours)

1 Introduction and first order equations — Ch. 0, 1 (6 hrs)

- Summary: 1st order + Euler: 6 lectures
- Introduction to ordinary differential equations (ODEs) — 0.1, 0.2
- Slope fields — 1.2
- First order linear ODEs and method of integrating factors — 1.4
- Separable equations — 1.3
- Existence and uniqueness — in 1.2
- substitution — 1.5
- autonomous equations — 1.6
- Euler's method — 1.7
- Applications in physics, chemistry and biology — various

2 Second order linear equations — Ch. 2 (9 hrs)

- Summary: 2nd order linear + appl: 8 or 9 lectures
- 2nd order linear equations, not much theory – No Wronskian etc. — 2.1
- Homogeneous equations with constant coefficients — 2.2
- Undetermined coefficients and variation of parameters — 2.5
- Mechanical and electrical vibrations — 2.4, 2.6

3 First order linear systems with constant coefficients — Ch. 3 (6 hrs)

- Summary: Lin syst: 6 lectures
- Homogeneous case — 3.1, 3.3, 3.4, 3.6
- Phase portrait for 2×2 systems — 3.5
- Fundamental matrix, nonhomogeneous case — no time

4 Nonlinear systems — Ch. 8 (5 hrs)

- Summary: Nonlin syst: 5 lectures
- Steady states and stability — 8.1, 8.2
- Linearization — 8.1, 8.2
- Phase portraits and applications

5 Laplace transform — Ch. 6 (5 hrs)

- Summary: Laplace transform: 5 lectures
- Definition and examples
- Solution of initial value problems
- Discontinuities
- Impulses and convolution

6 Numerical solutions — Ch. 8 of BDP (3 hrs)

- truncation error for Euler's method — BDP 8.2
- Improved Euler and Runge-Kutta methods — 8.3-8.4
- Adaptive step sizes, ode45 ?

Class Tests — (2 hrs)

Review — (1 hr)

Total time — 37 hrs

original file Y.X. Li, modified by W. Nagata January 25, 2019