Math 250b: Spring Semester 2008

SYLLABUS

(organized by math topics)

1/2/2008 (draft 3)

PRELIMINARIES & MODELING METHODOLOGY

Introduction 1.1-1.2

1. Thursday, January 17:
2. Tuesday, January 22: Introduction 1.1, 1.2

FIRST ORDER EQUATIONS

1. Fundamentals

Chapter 1

Solutions, the Fundamental Theorem,
graphic approximations, numeric approximations

3. Thursday, January 24
4. Tuesday, January 29

2. Linear First Order Equations

Chapter 2

General solution & initial value problems, Variation of Constant formula,
homogeneous & non-homogeneous equations, method of undetermined coefficients,
autonomous equations (equilibria, stability, phase line portraits)

5. Thursday, January 31
6. Tuesday, February 5
7. Thursday, February 7

Test #1

8. Tuesday, February 12

3. Nonlinear First Order - Autonomous equations
(qualitative theory & methods)

Chapter 3.1

Phase line portraits, equilibria, attractors/repellers/sinks, linearization,
qualitative equivalence, dependence on parameters & bifurcations

9. Thursday, February 14
10. Tuesday, February 19
11. Thursday, February 21

4. Nonlinear first Order - Non-autonomous equations
(analytic methods)

Chapter 3.2-3.4

Solution formulas: separable equations, change of variables
Approximation formulas: Taylor polynomial methods (regular perturbations)

12. Tuesday, February 26
13. Thursday, February 28
14. Tuesday, March 4

Test #2

15. Thursday, March 6

SYSTEMS & HIGHER ORDER EQUATIONS

1. Fundamentals
Chapter 4.1
Conversion of higher order equations to systems, Fundamental Theorem, graphic approximations, numeric approximations

16. Tuesday, March 11

2. Linear Systems - Basics
Chapter 4.2
Structure of general solution, initial value problems

17. Thursday, March 13

Spring Break: March 15-23

3. Linear Systems – Autonomous Homogeneous
Chapter 5.1 - 5.5
Solution formulas (using eigenvalues), short cuts for 2^{nd} order equation, construction & classification of phase plane portraits (nodes, saddles, spirals, centers), stability

18. Tuesday, March 25
19. Thursday, March 27
20. Tuesday, April 1
21. Thursday, April 3
22. Tuesday, April 8
23. Thursday, April 10

4. Linear Systems – Autonomous Non-homogeneous
Chapter 6.1 - 6.2
Variation of Constants formula, method of undetermined coefficients for 2^{nd} order equations

24. Tuesday, April 15

5. Autonomous Nonlinear Systems – Equilibria
Chapter 8.1 - 8.3
Equilibria, stability, linearization, Fundamental Theorem of Stability, local phase portraits for hyperbolic equilibria

25. Thursday, April 17
26. Tuesday, April 22
27. Thursday, April 24

6. Autonomous Nonlinear Systems – Oscillations
Chapter 8.5
Periodic solutions, limit cycles, bifurcations & Hopf criteria

28. Tuesday, April 29

Test #3

29. Thursday, May 1

Review

30. Tuesday, May 6

Projects

Students will be required to research and write up several projects during the semester. These will be based on the case study applications that appear at the end of each chapter of the text. Students will be asked to read an application from the text and write about it in their own words. They will also work several exercises from the text that are related to the project. The written report will require a format structured on the modeling methodology that will be discussed in the course (as summarized in the “modeling cycle” diagram in the introduction). This methodology involves several specific steps in the modeling of a phenomenon by means of which one can organize and orient one’s thinking (derivation, analysis, interpretation, critique & modification). The specific projects and topics given in the text are carefully designed to use all of the mathematical topics, methods, theorems, etc. given in the text; so there is a close tie between the applications & the mathematics. There are applications from at least three scientific disciplines after each chapter and most are developed and elaborated on throughout the chapters of the book. The projects also allow for the possibility of extending the application beyond what is presented in the text.