

## CAS MA 226 E DR Differential Equations SEMESTER II / 2004

### Instructors:

#### *Lecture:*

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#### *Discussion Class Instructor:*

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In this course, we study the solutions of ordinary differential equations using a three-pronged approach. Solutions are obtained using analytic, geometric, and numerical techniques. All three approaches have their advantages, and we will learn when to use the appropriate technique. We begin by deriving a few classical examples with an emphasis on the phenomena that they model. We then discuss first-order equations using all of the techniques mentioned above. Next we study first-order systems. Using techniques from linear algebra, we derive a systematic approach to the solution of linear systems. Unfortunately, non-linear systems are more difficult to investigate, but we learn how to apply what we know from the linear case to the non-linear case. For the numerical integration of stiff differential equations we study backward Euler and other implicit methods. The course concludes with a discussion of Laplace transforms. Our goal is to be able to say as much as possible about the solutions of a differential equation even if those solutions cannot be expressed in terms of the standard elementary functions (polynomial, rational functions, trigonometric functions, etc.).

**Lectures: Mondays 1.00 – 2.30 p.m., WIL/A120, Wednesday, 9.20 – 10.50 a.m., WIL/A129**  
**Discussion: Tuesday, 11.10 – 12.40 a.m., PHY/D16/U**

### Text:

Blanchard, Devaney, and Hall: Differential Equations (first edition),  
Brooks/Cole Publishing Company, 1998. ISBN 0-534-34550-6.

Other suggested reading:

W. Walter: Ordinary Differential Equations, Graduate Texts in Mathematics,  
Springer Verlag, New York, 2000. ISBN 0-387-98459-3.

H.-G. Roos and H. Schwetlick: Numerische Mathematik, Teubner {Texte zur Mathematik,  
Stuttgart, Leipzig, 1999. ISBN 3-519-00221-3.

WWW: [http://www.math.tu-dresden.de/wir/sta\\_/walther/BU.html](http://www.math.tu-dresden.de/wir/sta_/walther/BU.html)

**Examination/Grading:**

We will have two in-class exams during the semester, all at the normal class time. They will be held on May 7th and June 12th. The final exam is scheduled for 11 a.m.-1.00 p.m. on July 10th. Please note the date of the final and make your travel arrangement now! University policy states that you must take the final at the scheduled time. In addition to the in-class exams, you will be required to submit written work during the semester. This work will include solutions to the homework, and one numerically-based lab report. This work will partially determine your "discussion section grade." Letter grades will be determined by applying the following weighting schemes to your grades.

Your best in-class exams . . . . .	20%
The remaining in-class exams . . . . .	15%
The final . . . . .	35%
Discussion section grade . . . . .	30%

**Time Lecture Section Discussion**

- 1      What is an ODE, Population Growth 1.1  
        Separation of Variable Techniques 1.2
  
- 2      Slope Fields, Existence & Uniqueness 1.3 + 1.5  
        Explicit Numerical Methods 1.4
  
- 3      Equilibria and Bifurcations 1.6 + 1.7  
        Linear Problems, Undetermined Coe\_cients 1.8, App A
  
- 4      First Order Systems 2.1 + 2.2  
        Holiday
  
- 5      In class exam I  
        Special Systems 2.3 + 2.5
  
- 6      Hamiltonian + Dissipative Systems 5.3 + 5.4  
        Symplectic Integrators
  
- 8      Holiday  
        Project Presentation
  
- 7      Linear Systems 3.1 + 3.2  
        Phaseplane for various Eigenvalues 3.3 + 3.4
  
- 9      Repeated Eigenvalues 3.5  
        Second Order Equation, 3D Systems 3.8
  
- 10     Forced Harmonic Oscillator 4.1 + 4.2  
        In class exam II
  
- 11     Resonance + Wrap Up 4.3  
        Equilibrium Point Analysis 5.1 + 5.2
  
- 12     Implicit Numerical Methods  
        Introduction to Laplace Transformation 6.1  
        Second Order Equation 6.3  
        Discontinuity + Impulse Forcing 6.2 + 6.4
  
- 14     Conclusion + Wrap Up 6.5 + 6.6  
        Final Exam