Mathematics 2250 - 2

Ordinary Differential Equations and Linear Algebra

Summer 2007

Time and Place: MWF – 10:00-11:00 a.m. in LCB 219

Instructor: Nessy Tania

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Class Webpage: http://www.math.utah.edu/~tania/math2250.html

Office Hours: T 11:00-12:00 a.m. & 3:00-5:00 p.m. or by appointment

Problem Session: T 10:00-11:00 a.m. in LCB 215

Textbook: *Differential Equations & Linear Algebra, custom edition*
by C.H. Edwards and D.E. Penney

Prerequisite: Math 1210 and 1220 or equivalent (first year Calculus with a brief introduction to linear differential equations). Students are also expected to be familiar with vectors, curves, velocity (tangent) and acceleration vectors either from Physics 2210 or Math 2210 or their equivalents (e.g. Math 1250-1260 or 1270-1280)

Course Outline

This course is an introduction to differential equations, and how they are used to model problems arising in engineering and science. Linear algebra is introduced as a tool for analyzing systems of differential equations, as well as standard linear equations. Computer projects will be assigned to enhance the material.

We will cover most of chapters 1-7 and 10 in the Edwards-Penney text. The course begins with first order differential equations, a subject which you touched on in Calculus. Recall that a differential equation is an equation involving an unknown function and its derivatives, that such equations often arise in science, and that the order of a differential equation is defined to be the highest order derivative occurring in the equation. The goal is to understand the solution functions to differential equations since these functions will be describing the scientific phenomena which led to the differential equation in the first place. In chapters one and two of Edwards-Penney we learn analytic techniques for solving certain first order DE's, the geometric meaning of graphs of solutions, and the numerical techniques for approximating solutions which are motivated by this geometric interpretation. We will carefully study the logistic population growth model from mathematical biology and various velocity-acceleration models from physics.

At this point in the course we will take a four week digression from differential equations, to learn the fundamentals of linear algebra in chapters 3-4. You need a basic understanding of this field of mathematics in order to talk meaningfully about the theory of higher order linear DE's and of systems of linear DE's. Chapter 3 starts out with matrix equations and the Gauss-Jordan method of solution. When you see such equations in high-school algebra you might be thinking of intersecting lines in the plane, or intersecting planes in space, or ways to balance chemical reactions, but the need to understand generally how to solve such equations is pervasive in science. From this concrete beginning we study abstract vector spaces in chapter 4. This abstract theory is useful not only to the understanding of Euclidean space $\mathbf{R}^n$ but it is also the framework which allows us to understand solution spaces to systems of linear differential equations.

In chapter 5 we will study the theory of second order and higher-order linear DE's, and focus on the ones which describe basic mechanical vibrations. You were introduced to these equations in Calculus, and we will treat them more completely now, including a careful study of forced oscillations and resonance.

To successfully model more complicated physical systems like shaking in multi-story buildings, one needs the framework of linear systems of differential equations. The linear algebra of eigenvalues and eigenvectors is developed in chapter 6 as a tool for studying systems of DE's in chapter 7, where for example eigenvalues and eigenvectors will be related to fundamental modes for mass-spring systems.

Our final course topic is the Laplace transform and its applications to the study of linear DE's, in chapter 10. This ``magic'' transform takes differential equations and ``transforms'' them into algebraic equations. You will have to see it in action to appreciate it. You will see, for example, that this method gives a powerful way to study forced oscillations in the physically important cases that the forcing terms are square waves or other discontinuous functions. Electrical engineers often use Laplace transform techniques to understand circuits.

Exams:
There will be two 60-minutes in-class examinations (closed book, scientific calculator only), as well as a comprehensive two-hours final exam. The dates for the exams are as listed:

Exam 1 – Friday, June 15
Exam 2 – Monday, July 16
Final – Thursday, August at 10 a.m. -12 p.m.

No Make-up Exam will be given

Students are allowed to take the exam ahead of test-dates only if prior arrangement has been made with the instructor. Such arrangement will only be approved in extra-ordinary and well-documented circumstances.

Assignment
Except otherwise noted, there will be **weekly assignments due every Wednesday in class.** Check the website regularly for homework. Weekly problem session is held every Tuesday for those of you who would like to have a place to discuss the homework together and/or with me.

In addition, there will be **four computer projects** related to the materials discussed in class. They will be written in the software package MAPLE. A introductory tutorial will be scheduled during the first week of the semester.

Grading

Tests (two exams)	**40%**
Final exam	**30%**
Computer projects	**20%**
Homework	**10%**

	88-89 B+	78-79 C+	68-69 D+	
100 -94 A	84-87 B	74-77 C	64-67 D	0-59 E
90-93 A-	80-83 B-	70-73 C-	60-63 D-	

Withdrawal Dates

Last day to drop	Wednesday, May 23
Last day to elect CR/NC	Tuesday, May 29
Last day to withdraw	Friday, June 22
Last day to reverse CR/NC	Friday, July 27

Tutoring Center
Free drop-in tutoring is available at the Mathematics Tutoring Center in T.B. Rushing Mathematics Center (basement adjacent to LCB and JWB). Their hours are:

Monday-Thursday 8 a.m. to 8 p.m.
Friday 8 a.m. to 6 p.m.

Make use of every resource you have to get help.

American with Disabilities Act
The ADA requires that reasonable accommodation be given for students with physical, cognitive, systemic, leaning, and psychiatric disabilities. Please contact the instructor and the Center for Disability Services (162 Olpin Union Building, 581-5020, V/TDD) at the beginning of the semester**,** to make arrangements for these accommodations.

Tentative Course Schedule

M	May 14	1.1 – 1.2	Intro. to ODEs and integral solutions
W	May 16	1.3	Slope fields. Existence and uniqueness of solutions
F	May 18	1.4	Separable equations
M	May 21	1.5	Linear first order equations (integrating factors)
W	May 23	2.1-2.2	Population models. Equilibrium and stability
F	May 25	2.2-2.3	Equilibrium and stability. Velocity and acceleration models
M	May 28	-	**Memorial Day – No Class**
W	May 30	2.3	Velocity and acceleration models
			Maple assignment 1 due
F	June 1	3.1-3.2	Intro to linear systems, Matrices and row operations
M	June 4	3.2-3.3	Gaussian Elimination. Reduced row echelon matrices
W	June 6	3.3-3.4	Reduced row echelon matrices. Matrix algebra
F	June 8	3.5	Matrix inverses
M	June 11	3.6	Determinants
W	June 13		REVIEW
F	June 15		**EXAM 1**
M	June 18	4.1-4.2	Vector space intro.
W	June 20	4.2-4.3	Linear independence, span, subspaces
			Maple assignment 2 due
F	June 22	4.3-4.4	Bases and dimension of vector spaces
M	June 25	4.5	Row and column spaces
W	June 27	4.7	General vector space
F	June 29	5.1-5.2	Second order ODEs. Solution for homogeneous equations
M	July 2	5.2-5.3	Linear equations with constant coefficients
W	July 4	-	**Independence Day – No Class**
F	July 6	5.4	Mechanical vibrations
M	July 9	5.5	Undetermined coefficients and variation of parameters
W	July 11	5.6	Forced oscillation and resonance
F	July 13		REVIEW

M	July 16		**EXAM 2**
W	July 18	6.1	Eigenvalues and eigenvectors
			Maple assignment 3 due
F	July 20	7.1-7.2	System of first order ODEs
M	July 23	7.3	Solution to first order system. Applications
W	July 25	7.4	Spring system
F	July 27	10.1-10.2	Laplace transform and application to IVPs
M	July 30	10.2-10.3	Laplace transform properties and application to IVPs
W	August 1		REVIEW
			Maple assignment 4 due

Final Exam – Thursday, August 2, 10:00 a.m. - 12:00 p.m.