MATH383
First Course in Differential Equations

Course syllabus

Times	TuTh 9:30AM-10:45AM, Phillips 332
Office hours	MoWe 2:00-3:00PM, and by email appointment, Chapman 451
Instructor	Sorin Mitran
Assistants	William Davis

(*The instructor reserves the right to make changes to the syllabus. Any changes will be announced as early as possible.*)

Mathematical models of phenomena in which a rate of change of the state variables is specified lead to formulation of differential equations. Such models arise throughout the physical, biological, and social sciences. This introductory course presents the theoretical framework for differential equations, reinforced by numerous applications and use of software systems.

Course goals

Upon course completion students:

- will be able to formulate a differential equation model;
- will be able to transform the differential equation model into a finite difference model;
- will acquire basic analytical techniques to solve differential equations by hand;
- will become proficient in use of software packages to solve differential equations;
- will learn the linear algebra framework underlying differential equation solution methods;
- will be adept at analysis of the qualitative behavior of solutions to differential equations.

Honor Code

Unless explicitly stated otherwise, all work is individual. You may discuss various approaches to homework problems with students, instructors, but must draft your answers by yourself.

Grading

Required work

- Weekly homework: 12 assignments x 4 points = 48 points.
- In-class tests: 3 tests x 12 points = 36 points.
- Comprehensive final examination: 16 points.

Supplemental work

- Extra credit: 3 topics x 4 points = 12 points.

Mapping of point scores to letter grades

Grade	Points	Grade	Points	Grade	Points	Grade	Points
A+	101-112	B+	86-90	C+	71-75	D+	56-60
A	96-100	B	81-85	C	66-70	D-	50-55
A-	91-95	B-	76-80	C-	61-65	F	0-49

Course policies

- Class attendance is expected and highly beneficial to understanding of course topics.
- Homework is to be submitted electronically through Sakai.
- Late homework is not accepted.
- Students are offered the opportunity to make up for 12 course points (i.e., 3 homeworks, or 1 in-class test) through extra credits posted on this web page every 3 weeks. This should accomodate a reasonable number of excused absences.
- There is no need to inform instructor of planned absences.

Examinations

• Three tests are scheduled during class hours, approximately once every 4 weeks, covering the material presented during that time period.

• The final examination covers *all* course material, and concentrates on verification of understanding of basic concepts rather than extensive computation or detalied knowledge of analytical techniques.

• Examinations after Covid-19 are open-book

• Practice tests are posted a few days prior to test date for students to become familiar with test format

Test	Date	Questions	Solutions	Practice test
1	01/28	test1.pdf	sol1.pdf	pt1.pdf
2	02/25	test2.pdf	sol2.pdf	pt2.pdf
3	04/07	test3.pdf	sol3.pdf	pt3.pdf pt3 Webinar
Final	05/01		final.pdf	

Course materials

Course topics

MOD. Differential models from the sciences.

1ST. First order differential equations.

IVP. The initial value problem

AP1. Applications of first-order differential equations.

LIN. Linear algebra in $\mathbb{R}^n$. Basic concepts.

VEC. Vector spaces of polynomials, exponentials,

2ND. Linear second order differential equations.

AP2. Applications of linear second order differential equations.

SER. Series solutions of linear second order differential equations.

SYS. Systems of differential equations.

NUM. Numerical methods.

SIR. Susceptible, Infected, Recovered model of infections.

DYN. Dynamical systems.

Textbook

The course uses an open textbook, *Elementary Differential Equations with Boundary Value Problems*, by William F. Trench. You may follow the link to download the textbook, and it is also available in the `/biblio` course subdirectory.

Class slides

Class notes will be provided to summarize class discussion, and are posted on this website. Textbook sections covered in each class are indicated in parantheses. Some lessons present material not covered in the textbook (LIN, VEC, DYN)

Week	End date	Topic	Tuesday	Thursday
01	01/9	MOD	-	Lesson01 (§1.1-1.2)
02	01/16	1ST	Lesson02 (§2.1-2.2)	Lesson03 (§2.4)
03	01/23	IVP	Lesson04 (§2.3)	Lesson05 (§2.5-6)
04	01/30	AP1	Test on (§1.1-2.6)	Lesson06 (§4.1-4.3)
05	02/06	LIN	Lesson07	Lesson08
06	02/13	VEC	Lesson09	Lesson10
07	02/20	2ND	Lesson11 (§5.1-5.2)	Lesson12 (§5.3-5.4)
08	02/27	AP2	Test on (§4.1-5.4)	Lesson13 (§6.1-6.2)
09	03/05	AP2	Lesson14 (§6.3)	Lesson15 (§6.4)
10	03/19	SER	Cancelled (Covid-19)	Cancelled (Covid-19)
11	03/26	SYS	Lesson18 (Webinar18) (§10.1-10.3)	Lesson19 (Webinar19)(§10.4-10.5)
12	04/02	NUM	Lesson20 (Webinar20)(§10.4-10.5)	Lesson21 (Webinar21) (§3.1-3)
13	04/09	NUM	Test on (§10, §3)	Test3 review
14	04/16	DYN	Lesson22 (Webinar22)	Lesson23 (Webinar23)
15	04/23		Course Review	Final Exam preparation

Homework

Homework generally consists of exercises from the textbook. Homework is graded by TA's. Pay particular attention to the homework solutions to learn how to succintly and correctly present mathematical answers.

Nr.	Issue Date	Due Date	Topic	Problems	Solution
01	01/09	01/16	MOD	hw01.tm hw01.pdf	sol01.pdf
02	01/16	01/23	1ST	hw02.tm hw02.pdf	sol02.pdf
03	01/23	01/30	IVP	hw03.tm hw03.pdf	sol03.pdf
04	01/30	02/06	AP1	hw04.tm hw04.pdf	sol04.pdf
05	02/06	02/13	LIN	hw05.tm hw05.pdf	sol05.pdf
06	02/13	02/20	VEC	hw06.tm hw06.pdf	sol06.pdf
07	02/20	02/27	2ND	hw07.tm hw07.pdf	sol07.pdf
08	03/01	03/06	AP2	hw08.tm hw08.pdf	sol08.pdf
09	HW09 cancelled due to Covid-19. 4 points awarded to all.				
10	03/26	04/02	SYS	hw10.tm hw10.pdf	sol10.pdf
11	04/02	04/09	NUM	hw11.tm hw11.pdf	sol11.pdf
12	04/16	04/23	DYN	hw12.tm hw12.pdf	sol12.pdf sol12.tm

Extra Credit

Extra credit is offered to make up for missed deadlines, absences. Extra credit is graded by Instructor. Correct solution of extra credit questions awards 12 course points. Student initiative in independently investigating additional aspects suggested by the extra credit problems can be rewarded by up to 12 additional points (on top of the 12 point value of the extra credit). Assessment of such student initiative is at the discretion of the Instructor. Examples include, but are not limited to:

- generalization of theorems, multiple proof techniques
- independent study into applications of a particular differential equation topic
- detailed computational investigation of non-trivial problems

Nr.	Issue Date	Due Date	Problems
01	01/23	02/13	ec01.tm ec01.pdf
02	02/20	04/09	ec02.tm ec02.pdf
03	04/09	04/23	ec03.tm ec03.pdf

Software

Modern software systems allow efficient, productive formulation and solution of mathematical models. A key goal of the course is to familiarize students with these capabilities, by presentation of three applications:

1. TeXmacs, a scientific editing platform, used to draft homework assignments;
2. Maxima, an open-source symbolic, numerical, and graphical computation package;
3. Mathematica, a commerical symbolic, numerical, and graphical computation package, available through a UNC site license

Installation

Students are requested to install the above programs on their CCI-compatible laptops through the following steps:

1. Create a course directory with no spaces in the path name, e.g., c:\MATH383
2. Install Maxima into c:\MATH383\maxima
3. Modify the System variable PATH to include c:\MATH383\maxima\bin
4. Install TeXmacs into c:\MATH383\texmacs

The above steps will allow Maxima computations to be included into TeXmacs documents. Demonstrations will be made in class, and in case of difficulty consult teaching assistants. Analogous steps are followed for Mac OS machines.

Tutorials

Software usage is introduced gradually in each class, so the first resource students should use is careful, active reading of the material posted in class. In particular, carry out small tasks until it becomes clear what the software commands accomplish. Some additional resources:

- TeXmacs
  - http://www.texmacs.org/tmweb/help/tutorial.en.html
  - https://www.youtube.com/watch?v=mlcqGRv7xhc
- Maxima
  - http://www.cfm.brown.edu/people/dobrush/am33/maxima/index.html

  - http://maxima.sourceforge.net/docs/tutorial/en/gaertner-tutorial-revision/Contents.htm
  - http://www.texmacs.org/tmweb/documents/tutorials/maxima-tutorial/maxima-tutorial.en.html
  - http://maxima.sourceforge.net/docs/manual/intromax.pdf
- Mathematica
  - http://www.wolfram.com/language/fast-introduction-for-math-students/en/
  - http://www.wolfram.com/wolfram-u/catalog/gen005/
  - http://www.wolfram.com/language/fast-introduction-for-programmers/en/

Course material repository

Course materials are stored in a repository that is accessed through the subversion utility, available on all major operating systems. The URL of the material is svn://mitran-lab.amath.unc.edu/courses/MATH383. Under Windows, Tortoise SVN can be used to download all course materials through the subversion utility, or individual files can be downloaded from this website.