Math 211: Ordinary Differential Equations (ODE) and Linear Algebra

(last updated: 2021-03-22)

Disclaimer

The policies of this syllabus are subject to change with reasonable advance notice.

Course Description

If mathematics is the language of the universe, the language of ODE is a ubiquitous dialect. Many important, diverse phenomena from nature turn into differential equations when mathematically modeled. We can often either solve these equations or give partial descriptions of their solutions, which helps us predict or approximate unknown features of the phenomena. For instance, the effects on population of the introduction of a new predator into an environment can be modeled by a differential equation, for which the solution can tell us whether the predator and prey can coexist perpetually or if, given enough time, one of the species will die out. We will study some fundamental methods for describing and finding solutions to differential equations, learn when to apply a particular method, and practice solving ODE and systems of ODE.

Course Objectives and Expected Learning Outcomes

We aim by the end of the course for you to be able to…

- …identify ODE when they arise outside the math classroom.
- …judge quickly whether an ODE is easy, difficult, or impossible to solve.
- …solve first-order ODE by a variety of techniques.
- …use fundamental linear algebra concepts and explain how they relate to ODE.
- …analyze second-order ODE, linear systems of first-order ODE, and phase portraits.
- …linearize nonlinear systems of first-order ODE and explain why you do.
- …solve ODE of various order using the Laplace Transform.

Course Information

Textbook

Most of the material we will study comes from *Differential Equations & Linear Algebra*, Second Edition, by Farlow, Hall, McDill, West. Below we will refer to this as ‘Farlow’. You are not required to purchase a copy of the textbook. Your learning will be well served if you secure access to material covering the following topics:

1. First-order ODE
2. Linearity
3. Linear Algebra
4. Higher-order linear ODE
5. Linear transformations
6. Linear systems
7. Nonlinear systems
8. Laplace transform

Logistics

Class time: 9:00am-9:50am, MWF
Classroom: RZR 119
Office hours: Mondays, 1:30pm-2:30pm
Tuesdays, 4:30-5:30pm or by appointment

Instructor Information

Instructor: Ethan Gwaltney
Office: HBH 47 (basement)
Email: ethan.gwaltney@rice.edu

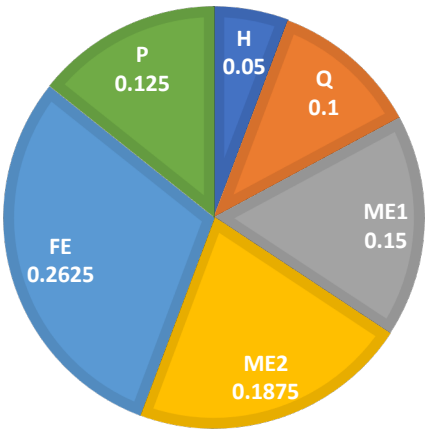
Grading Policy

We will assess progress using the following tools:

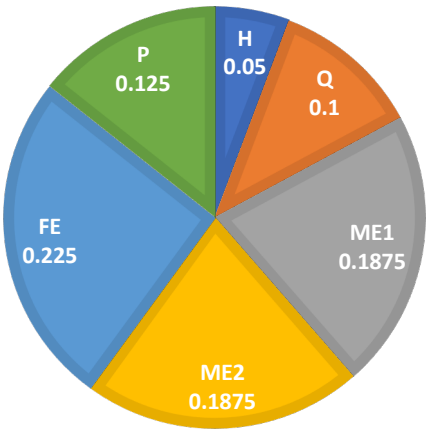
1. Homework (H). Weekly homework will be due on the Friday following its assignment. Homework will be graded on correctness and work shown and will be annotated with comments for review.
2. Quizzes (Q). Weekly take home quizzes will be due on the Monday following their assignment. Quizzes are practice for exams, and, as such, should first be taken timed in one color, then reviewed and edited in a different color. Instructions with more details can be found on each quiz. Quizzes are graded in their post-edits form.
3. Exams (E). There will be two midterm exams (ME) and one final exam (FE). The midterm on which you receive higher marks we will call ME2, the one on which you receive lower marks, ME1. ME1 will be worth less that ME2 in your final grade distribution (see the chart below). See below for exam dates.
4. Projects (P). You will complete a series of small projects throughout the course. Projects will provide alternative media (writing, presentation, research, speaking, etc.) by which you can demonstrate your understanding to help counterbalance any 'false negatives' in assessment produced by test anxiety and other testing variables less interesting to me than your understanding of ODE and linear algebra. They also offer opportunities to develop skills important to facility in math, such as talking about math coherently. Projects also offer a venue in which you can connect class material to ODE in the world. More details on these projects will come as they are assigned (e.g., rubrics).

How is your grade calculated? Your final average is determined using the above assessments by the maximum of the following distributions:

GRADE DISTRIBUTION 1



GRADE DISTRIBUTION 2



Absence Policy

You are strongly encouraged, but not required, to attend class. As I will sometimes ask you to collaborate with your peers both inside and outside the classroom, please keep in mind the disservice you do your peers by failing to attend in addition to the disservice you do yourself.

Rice Honor Code

As a student at Rice University, you pledge to uphold the Rice Honor Code, of which you can remind yourself in the Honor System Handbook.

On homework, all resources are permitted. In particular, you are strongly encouraged to work with one another. The purpose of the homework is to internalize the language and practice of differential equations, which is often best facilitated in communication with peers.

On quizzes and exams, no external resources are permitted. The purpose of quizzes and exams is to help you see what you can do so far and what you need to work on, as well as to help me, as instructor, see where the course has catalyzed your learning and where it could do so better.

Hospitality

My ideal for the classroom is one in which every student is excited about the course and feels welcome. We might think of me as a host—I set the tone and decide the meal, as it were, and, if I'm a good host, I make you feel welcome. This vision motivates several of the design elements for the course. If you have comments, complaints, suggestions, etc., please email me with the subject "Hospitality". If you'd prefer to remain anonymous, use the following email account:
Address: anonymousowl.211@gmail.com
Password: Math211Spring2020

Students with Disabilities

If you are a student with a documented disability that requires accommodation, I encourage you to contact the Rice Disability Resource Center (adarice@rice.edu; Allen Center, Room 111) and me (ethan.gwaltney@rice.edu).

Resources

Potentially helpful resources:

- Past exams can be found on the Calculus Resources page on Canvas.
- Graduate students from the math department hold help sessions Monday through Thursday for two hours at a time. Sessions are held Monday through Thursday, 7-9pm in Herring 129.
- For help with projects involving writing or presenting, consider visiting the Rice Center for Academic and Professional Communication, a free resource to all Rice students.

See below for a preliminary schedule of course topics and events!

Calendar

Below is a preliminary schedule of class topics and events. Section numbers and exercise numbers refer to Farlow—these problems will also be posted on Canvas in worksheet form. Exercises are assigned on the date of the line on which they appear and due the following Friday. **Project due dates** are indicated in blue and bold. ***Exams dates*** are italicized, underlined, and in bold.

Day	Date	Topic(s)	Sections	Exercises // Projects Due
M	13 Jan	Modeling Dynamical Systems	1.1	//
W	15 Jan	Analysis of Slope Fields	1.2	//
F	17 Jan	Separation of Variables	1.3	1.1#7, 1.2#7,15, 1.3#5,7,9,17//
W	**22 Jan**	Picard's Theorem for Existence & Uniqueness of Solutions	1.5	// **Why I'm still in school**
F	24 Jan	Linearity	2.1	1.5#1,7,9,20, 2.1#5,7,13,15,43,45 //
M	27 Jan	First-order Linear ODE	2.2	//
W	29 Jan	Solving FOL ODE in Applications	2.3-2.4	//
F	31 Jan	Finite Matrices	3.1	2.2#3,9,19,23,33, 2.3#31, 2.4#17 or #21, 3.1#5,12,23,61,69,73//
M	3 Feb	Row Reduction of Matrices	3.2	//
W	**5 Feb**	Reading RREF	3.2	// **ODE Scavenger Hunt**
F	7 Feb	Invertible Matrices	3.3	3.2#17,19,24,37,73, 3.3#5,11,17,18,25,37,43//
M	10 Feb	Determinant	3.4	//
T	***11 Feb***	***First Midterm Written Exam***	1.1-3.3	7-9pm
W	12 Feb	Vector Spaces	3.5	3.4#1,5,15,33, 3.5#11,15,23,37,45,71//
M	17 Feb	Span, Subspaces	3.6	//
W	19 Feb	Bases and Dimensions of Vector Spaces	3.6	//
F	21 Feb	Solving Constant Coefficient Second Order Linear ODE	4.2	3.6#1,5,7,9,31,57,67,69, 4.2#3,9,21,23//
M	24 Feb	Autonomous ODE and Phase Lines	2.5	//
W	26 Feb	Complex Roots of the Characteristic Equation	4.3	//
F	28 Feb	Method of Undetermined Coefficients	4.4	2.5#5,7, 4.3#11,31,35,41, 4.4#23,29,41,51,58//
M	2 Mar	Variation of Parameters	4.5	//
W	4 Mar	Linear Transformations	5.1	//
F	6 Mar	Injectivity, Surjectivity, Rank, Kernel	5.2	4.5#7, 5.1#4.29,47, 5.2#7,31,35,45,61, 5.3#7//
M	9 Mar	BREAK		
W	11 Mar	BREAK		
F	13 Mar	BREAK		
M	23 Mar	Eigenvalues & Eigenvectors	5.3	//
W	25 Mar	Coordinatization	5.4	//
F	27 Mar	Diagonalization	5.4	5.4#1,3,9,27,45,49,52//
M	30 Mar	Linear Systems of ODE	6.1	//
W	***1 Apr***	***Second Midterm Written Exam***	3.5-5.3	5pm, to be submitted 5pm 4/3
W	1 Apr	Systems with Real Eigenvalues	6.2	//
F	3 Apr	Systems with Complex Eigenvalues	6.3	6.1#5,21, 6.2#11//
M	6 Apr	Systems with Complex Eigenvalues	6.3	//
W	8 Apr	Stability	6.4	//
F	10 Apr	Stability	6.4	6.2#52, 6.3#13,39, 6.4#18//
M	13 Apr	Decoupling	6.5	//
W	15 Apr	Matrix Exponential	6.6	//
F	17 Apr	Matrix Exponential	6.6	6.5#5,15, 6.6#13, 6.7#15, 7.1#17//
M	20 Apr	Nonlinear Systems of ODE	7.1	//
W	22 Apr	Linearization	7.2	//
F	**24 Apr**	Laplace Transform	8.1	// **Project Revisions Due**