

Syllabus for Math 292, Honors Calculus IV (Differential Equations), Spring 2018

All reading assignments are to chapters in the online text, *Differential Equations* by Eric Carlen.

The purpose of this course is to provide a thorough introduction to the theory of Ordinary Differential Equations, including proofs of the main theorems, but also covering techniques of solution and explicit calculation. A significant amount of linear algebra will be developed along the way.

The peer mentor for the course is Dylan Forenzo, dtf32 at scarletmail.rutgers.edu. He will run the Challenge Problems Workshops listed below.

WEEK 1: Jan 17, 18: (Introduction, separable, Bernouli and Ricatti equations; reduction of order)

Reading: Sections 1.1-2.4 of Chapter 1.

WEEK 2: Jan. 22, 24, 26: (Flows on the real line; that is, first order autonomous equations in one variable)

Reading: Sections 1.1-4.2 in Chapter 2.

WEEK 3: Jan. 29, 31, Feb. 1: (Flows in n variables, decoupling methods. Linear systems.)

Reading: Sections 1-3 in Chapter 3.

First homework assignment: due Mon, Jan 29.

WEEK 4: Feb 5, 7, 8: (The matrix exponential with complex eigenvalues, Duhamel's formula)

Reading: Sections 4 in Chapter 3, 1.1 and 1.2 in Chapter 4.

First Challenge Problem workshop: Mon., Feb 5.

Second homework assignment: due Wed., Feb 7.

WEEK 5: Feb. 12, 14, 15: (Equilibrium points for first order systems, various types of stability.)

Reading: Sections 4.3, 4.4 of Chapter 4.

Second Challenge Problem workshop: Wed., Feb 14

Third homework assignment: due Thr., Feb 15.

WEEK 6: Feb. 19, 21, 22: (Oscillations of mechanical systems, normal modes, driven oscillations and resonance)

Reading: Sections 3 and 4 of Chapter 4 continued

Fourth homework assignment due: Thr., Feb 22

WEEK 7: Feb. 26, 28, Mar. 1:

Reading: Section 1.1 to 2.4 of Chapter 5. (Piccard's Theorem: Existence, uniqueness and properties of solutions.)

• **First Midterm Exam** Thr., Mar 1. This will be based on the material from weeks 1 through 6.

WEEK 8: Mar. 5, 7, 8: Review and consolidation

Reading: Review

Fifth homework assignment due: Thr., Mar 8.

Third Challenge Problem workshop: Mon, Mar. 5

WEEK 9: Mar. 19, 21, 22:

Reading: Sections 1.1-1.5 of Chapter 6 (Boundary value problems for second order equations. Application to the wave equation)

WEEK 10: Mar. 26, 28, 29: (Sturm-Liouville operators and the Sturm-Liouville eigenvalue problem.)

Reading: Sections 2.1-2.2 of Chapter 6

Sixth homework assignment due: Thr., Mar. 29.

Fourth Challenge Problem workshop: Mon., Mar. 26

WEEK 11: Apr. 2, 4, 5: (Green's functions: Inverting Sturm-Liouville operators)

Reading: Sections 1.1-1.2 of Chapter 7

Seventh homework assignment due: Wed Apr. 4

WEEK 12: Apr. 9, 11, 12: (Applications and further aspects of the theory of boundary value problems)

Reading: Sections 2.1.2.5 of Chapter 7

WEEK 13: Apr. 16, 18, 19: (Calculus of variations, introduction and the Euler equation)

Reading: Sections 1.1 to 2.2 Chapter 8

Fifth Challenge Problem workshop: Mon, Apr. 16

Eighth homework assignment due: Thr. Apr. 19

WEEK 14: Apr. 23, 25, 26: (Calculus of variations: When are solutions of the Euler equation actually optimizers?)

Reading: Sections 3.1-3.4 Chapter 8

Sixth Challenge Problem workshop: Mon., Apr. 23

• **Second Midterm Exam:** Thr., Apr. 26

WEEK 15: Apr. 30:

Reading: Review

Ninth homework assignment due: Mon, Apr. 30.

FINAL EXAM: Not yet scheduled.