Syllabus

Basic logistics

- Instructor: Paul T Allen, Bodine Hall 306, `ptallenlclark.edu`
- Meeting times: The course meets 9:10 – 10:10 on Monday, Wednesday, Friday in JR Howard Hall 102
- Textbook: This packet serves as the textbook for this course.
  - If you would like to have a traditional book to use as a supplemental resource, please ask Paul for a complimentary book.
  - Open textbooks are available online through the AIM Open Textbook Initiative at https://aimath.org/textbooks/approved-textbooks/.

Goals

The goal of this class is that students both learn the "technical tools" used to study differential equations and also the "big picture" of how those tools can be used. Thus students completing this course are expected to be able to do the following...

- construct differential equations from a set of modeling assumptions.
- analyze ODEs by finding analytic solutions (as appropriate/possiible), by using numerical techniques, and through methods of qualitative analysis.
- interpret the results of their mathematical analyses within the context of the modeling assumptions.
- communicate their findings in written form.

In order to accomplish these goals, students are to develop the following skills:

- reasoning skills used in qualitative analysis, including geometric and graphical reasoning.
- computational and formal analytic skills used to form and manipulate ODEs, to obtain exact solutions to ODEs, etc.
- computational and technical writing skills using Jupyter notebooks, markdown, LaTeX, and Sage.

Homework

- Homework is assigned on most class days. Be sure to start the homework as soon as it is assigned!
- Students are encouraged to collaborate on assignments, but must submit their own work for evaluation. If you work with other students, be sure that you understand each step of what is being done!
- When submitting work, please make sure that
  - your name and the assignment number/title are clearly written at the top of the first page,
  - your work is neatly presented, and
  - all pages are stapled together.

  Work that does not meet these standards are at risk of being placed in to one my "miscellaneous" folders, from which few documents ever return.
- All homework is to be submitted to the box in the SQRC.
- In general, credit is not given for late or incomplete work. I may, at my discretion, accept late work and file it away; such work is considered only if your course grade is borderline.

Computational and writing assignments

- During the first part of the course, there are weekly technology assignments that involves using Jupyter notebooks, LaTeX typesetting syntax, and the Sage mathematical programming language.
- In the latter part of the course, there are longer writing assignments that require you to use the technical skills developed in the first part of the course.

Exams

- There are three in-class exams. Exam dates are:
  - Friday 27 September
  - Friday 1 November
  - Friday 6 December

  Exams can be rescheduled only in cases involving documented extenuating circumstances.

- There is a cumulative final exam, given during the official final exam period as listed on the College Registrar's website: Wednesday 18 December 8:30-11:30am. This exam cannot be rescheduled (except as permitted by official college policy). Do not plan holiday travel that conflicts with the final exam period!

Citizenship

I expect good academic citizenship from all students in this course.

Citizenship in this class It is important to treat our joint academic endeavor respectfully and responsibly. This includes

- being respectful of yourself;
- being respectful of your fellow classmates, faculty, staff, etc; and
- begin respectful of the course material and the learning process.

Citizenship in the LC community All students are expected to be an active and responsible member of our college community. In order to encourage this, you are required to attend two (2) official LC events during the semester. These events cannot be required of another course you are enrolled in, and must be officially advertised or sponsored in some way.

After you have attended each event, you need to complete an online google form to record the event. A link is on the course website.

You can find out about events on campus via the online campus calendar.

Course grades

Course grades are determined by the following procedure:

1. First, a preliminary course grade is computed using an average of scores, weighted as follows:
   - Homework & citizenship: 2/9
   - Exams: 3/9
   - Technology & writing assignments: 2/9
   - Final Exam: 2/9
2. After computing the preliminary grade, I make adjustments based on inconsistent coursework (such as disregarding an outlier), trends throughout the semester (such as improvement), and other factors I deem relevant. Students who have not demonstrated good academic citizenship will have their grades adjusted downward during this phase of the grading procedure.
3. Finally, I revisit the individual grades in view of the grade definitions provided by the College Catalog, seeking indicators of the synthesis of course material.

I emphasize that **ultimately grades are assigned according to the definitions in the college catalog**, based on my assessment of the student's knowledge and synthesis of the course material, as documented by the assignments and exams. While a weighted average of individual scores is a critical tool for making this assessment, in no way is such an average definitive.

Finally, I note that students fail the course if either of the following occurs:

- Insufficient participation: Missing the equivalent of two weeks of class sessions, or missing one of the exams, will lead to a failing grade. Exceptions to this policy require documented extenuating circumstances.
- Gross negligence: Demonstration of gross ignorance or complete lack of understanding of key concepts on exams will lead to a failing grade. In particular, a student who has accumulated what might be construed as 'technically enough points to pass' but demonstrates a "clearly inadequate" lack of understanding which is "unworthy of credit" will be awarded a failing grade.

4.0 grading scheme

All coursework is graded on the 4.0 scale. The mapping between numerical and letter grades, together with the official definitions (taken from "Policies and Procedures" section of the Undergraduate Catalog), is as follows. The italics indicate an interpretation of the official definitions for the purposes of mathematics courses.

Grade A (4.0) Outstanding work that goes beyond analysis of course material to synthesize concepts in a valid and/or novel or creative way.

Computational problems are completely and correctly executed in a manner which displays a complete grasp of the theory behind the computation. Theoretical responses display a thorough understanding of the both precise details and the larger framework at hand.

Grade B (3.0) Very good to excellent work that analyzes material explored in class and is a reasonable attempt to synthesize material.

Computational problems are executed with minimal, insignificant errors (such as dropping a sign) and contain some indication that the relevant theory being used is understood. Theoretical responses display significant progress towards understanding of how the details fit in to a larger framework.

Grade C (2.0) Adequate work that satisfies the assignment, a limited analysis of material explored in class.

Solutions to computational problems display significant, though perhaps mechanical, understanding of basic procedures. Theoretical responses display an preliminary understanding of the topic at hand, but lack connections to the larger framework.

Grade D (1.0) Passing work that is minimally adequate, raising serious concern about readiness to continue in the field.

Both computational and theoretical responses display some non-trivial knowledge and skills, but raise concerns about whether basic ideas and methods are understood.

Grade F (0.0) Failing work that is clearly inadequate, unworthy of credit.

Fundamental misunderstandings, mis-use of methods or theory, seemingly random or un-related material, etc.

Tentative schedule

Week 1 (2–6 September)	Labor Day holiday What is a differential equation? Constructing differential equations and IVPs →Technology: First notebook
Week 2 (9–13 September)	What is a solution to a differential equation? Separable equations & IVP Propagator functions →Technology: Introduction to Sage; plotting functions
Week 3 (16–20 September)	Integrating factors Slope fields Numerical solutions (Euler's method) →Technology: Slope fields
Week 4 (23–27 September)	FTODE Technology day Exam on first order equations →Technology: Euler's method
Week 5 (30 September–4 October)	First order systems, parametric curves, vector fields (Numerical methods for systems) Nullclines and equilibrium points for systems →Technology: parametric plotting; Euler's method
Week 6 (7–11 October)	Linearization Tools for linear equations Fall Break on 11 October →Technology: warm-up writing assignment
Week 7 (14–18 October)	Eigenstuff Linear theory with real eigenvalues Complex numbers →Technology: collect/discuss writing assignment
Week 8 (21–25 October)	Linear theory with complex eigenvalues Linear theory with repeated eigenvalues Return to nonlinear systems →Technology: distribute SIR writing assignment

Week 9 (28 October – 1 November)	Practice / exam review (Linear systems with repeated eigenvalues) Exam on nonlinear systems →Technology: work on SIR assignment
Week 10 (4–8 November)	Conservation of energy Energy diagrams The nonlinear pendulum →Technology: collect SIR writing assignment
Week 11 (11–15 November)	Conservation and damping Practice / examples Conservation in 2D motion →Technology: distribute Gravitation writing assignment
Week 12 (18–22 November)	Oscillations and homogeneous equations Oscillators with forcing Trigonometric forcing →Technology: work on Gravitation assignment
Week 13 (25–29 November)	Resonance I Resonance II Thanksgiving Break 28-29 November →Technology: work on Gravitation assignment
Week 14 (2–6 December)	Coupled oscillators I Coupled oscillators II Exam 3: Conservation laws and oscillations →Technology: Gravitation assignment due
Week 15 (9–13 December)	Flex day Course evaluation day Reading Period 13 December
Final Exam	Wednesday 18 December 8:30-11:30