MATH 244 §F1 COURSE SYLLABUS

RUTGERS UNIVERSITY, 2022 SUMMER SESSION

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Contents

§ 1. Prerequisites

Calculus III (Rutgers Math 251 - Multivariable Calculus). Topics from all of the calculus courses will come up in this class, and will be necessary to answer many if not most questions. If you do not feel confident in your calculus abilities you should contact me sooner rather than later.

§ 2. Quick Info

This course is online.

- Class dates: 2022-06-27 to 2022-08-17 on Mondays, Tuesdays, Wednesdays, and Thursdays.
- Class times: from 10:30 AM to 12:25 PM Eastern Daylight Time.
- Lecture Link: https://rutgers.zoom.us/j/91995477023?pwd=eTBaZ09xUFVId1N0WVFMNVlKaTVFUT09
- Office Hours: 1:30 PM to 2:30 PM Eastern Daylight Time on Tuesdays and Wednesdays.
- Office Hours Link: https://rutgers.zoom.us/j/99248509500?pwd=Z1VjOUJrbU40QldGcml4VWRVUXFVUT09
- Textbook: Differential Equations (An Introduction for Engineers) by Matthew Charnley.
- Class website: https://rutgers.instructure.com/courses/181683.
- My email: jch258@math.rutgers.edu

§ 3. Contact Info

Here is some info about me and how to get into contact outside of class.

- My name: James Holland. You can address me as "James".
- My email: jch258@math.rutgers.edu, or
  james.c.holland@rutgers.edu.
- Office Hours: 1:30–2:30pm EDT on Tuesdays and Wednesdays.

You can just email me if you want to meet outside of office hours. I highly encourage you to come to office hours; in a loose sense it's free tutoring (that you sort of already paid for).

§ 4. Topics Covered

There are four major areas covered in this course.

- **First-order ODEs** (ordinary differential equations): Slope fields, Separable equations, Linear equations, Euler's method, Existence and uniqueness, Autonomous equations, applications.
- **Second-order ODEs**: Second order linear equations, Real, Complex, Repeated roots, Mechanical vibrations, Forced oscillations and resonance, Nonhomogeneous equations.
- **Linear algebra and systems of ODEs**: Vectors and matrices, Row reduction, Determinant, Eigenvalues and eigenvectors, System of ODEs, Eigenvalue method, Two-dimensional systems.
- **Non-linear systems**: Linearization, Critical points and stability, Applications of nonlinear systems

§ 5. Diversity and Inclusion

Words like "diversity" and "inclusion" are just about people feeling comfortable, respected, and represented in their communities (and classes). Note that all of this means different things to different people. Students in this class (and people generally) will be coming from different backgrounds that informs not only how they view the world, but also how they want the world to view them. I will try my best, but here are some suggestions to help me do better.

- If there is a way you'd prefer I use to refer to you (especially if it's not reflected in the official roster), please let me know. And please correct me if I make a mistake.
- Many cultures perceive directness as rude or harsh. If you'd prefer I be more subtle or indirect, don't be afraid let me know! Other issues of communication style also apply.
- Other students are also expected to follow these ideas. If another student in the class makes you feel unwelcome or uncomfortable (in or outside of class), please let me know.
- If an issue arises that you and I are unable to resolve directly, or you'd prefer to discuss with someone else, you may contact the Director of Summer Instruction for the Math department, Professor Molnar, at the email address summerprogram@math.rutgers.edu.

§ 6. Course Content and Class Time Breakdown

Textbook: Differential Equations (An Introduction for Engineers) by Matthew Charnley.

We will be using Matthew Charnley's book located here. The textbook is free and derived from open source content, but it is also a work in progress. As such, there might be typos. This course has received an 'Open and Affordable Textbooks Program award from the Rutgers University Libraries. The OAT Program supports textbook affordability at Rutgers by encouraging courses to adopt educational materials that are freely available, available at a low cost (compared to similar courses), or part of the Rutgers University Libraries' electronic collections, and thereby free of charge to Rutgers University students. As a student in this course, you will be asked to provide feedback on this initiative at the end of the semester.

Each class is broken up into two large chunks with a short chunk in the middle. A general class will be the following:

- (5 minutes) A short poll question
- (40–45 minutes) Lecture part 1
- (10–15 minutes) A short quiz or two
- (40–45 minutes) Lecture part 2
- (10–15 minutes) A short quiz or two

The classes will be recorded and posted on the canvas website under "Media Gallery". Each class meeting will include usually 3 short quizzes consisting of just 1–2 questions each broken down by section of the textbook. Each week there will be one to two homework assignments and a MATLAB assignment due. Additionally, there will be three tests, and one final exam.

This is overall a lot of work, but that's necessary when a full semester's worth of content is compressed into 8 weeks. I will try my best to make sure you do not die from this, but part of that is letting me know when you're struggling (cf. Section 2 and Section 14).

§ 7. Learning Goals

This course is graded with a "mastery-based grading system", which means the content of the course is classified into certain topics called "learning goals" that you are supposed to learn about and demonstrate ability in.

The topics of the course are listed in Section 4 and these are covered by 24 learning goals which are broken down as follows (including an abbreviation):

1. (**BG**) Background
2. (**Term**) Classification, Graphs, and Terminology
3. (**IVP**) Initial Value Problems
4. (**CN**) Complex Numbers
5. (**Mod**) Modelling Systems

- Five learning goals related to First-Order Methods:
  6. (**FOAE**) Autonomous Equations
  7. (**FODM**) Discrete Methods
  8. (**FOEE**) Exact Equations
  9. (**FOLE**) Linear Equations
  10. (**FOSE**) Separable Equations
- Six learning goals related to Second-Order Methods:
  11. (**SORR**) Roots and Reduction of Order
  12. (**SOLE**) Second-Order Linear Equations
  13. (**Phys**) Stuff motivated by physics
  14. (**Wron**) The Wronskian
  15. (**UC**) Undetermined Coefficients
  16. (**VP**) Variation of Parameters
- Four learning goals related to Introductory Linear Algebra
  17. (**Eig**) Eigenvalues and Eigenvectors
  18. (**Elim**) Elimination
  19. (**LI**) Linear Independence
  20. (**MAlg**) Matrix Algebra, Determinants, and Inverses
- Three learning goals related to Systems of Equations
  21. (**SysHom**) Homogeneous Systems with Constant Coefficients
  22. (**SysLin**) Linearization
  23. (**SysNHom**) Nonhomogeneous Linear Systems

24. MATLAB

The idea is that your understanding of the material of the course is measured by your ability in each learning goal separately: you might have total ability with initial value problems but fail to understand first-order linear systems of equations, for example.

Your final grade will collect together your performance in these learning goals as detailed in Section 10 give a letter grade. So in that sense, this grading system isn't revolutionary. But the idea isn't to change the university's notion of grades, GPA, etc. but instead to give you feedback about how well you actually understand the material in a way that is broken down by topic.

§ 8. Grading Assignments

There are 5 types of assignments, all of which should be submitted on the Canvas site, and a schedule of which can be found in Section 15.

- Quizzes - one to two short problems (two to three of these per day).
- Homework - several problems of varying length.
- Tests - many longer problems.
- The final exam - many longer problems.
- MATLAB assignments - guided problems.

Each answer to a problem will be graded with a rough grade of:

- 0 - not gradable
- 1 - ability not yet demonstrated.
- 2 - some ability demonstrated.
- 3 - total ability demonstrated.

Minor algebraic errors that don't substantially affect the solution will still get a '3'. Minor algebraic errors that unfortunately *do* affect the structure of the solution will not get a '3'. For the most part, I'm interested in your ability to understand how to solve differential equations. I'm not nearly as interested in your ability to evaluate integrals and derivatives although these will be necessary for many parts of the course.

Often the quizzes will be graded using Canvas' automatic grader. This grader is imperfect for a number of reasons, so I will be grading them manually just as a quick check. The score you see after taking the quiz may not be the grade you end up receiving. Indeed, you won't be receiving a traditional point-based grade but instead one associated to how well you have demonstrated your ability in a certain learning goal.

§ 9. Grading Learning Goals

This is a mastery-based grading system. What that means is that the course is broken down into several different learning goals which are graded individually, and then the grades for these goals are collected together in some way to form your grade at the end of the course.

There are a total of 24 learning goals in this course. Each learning goal can be *failed*, *passed*, or *mastered* on an assignment.

- **Passing** a learning goal means getting an average of ≥ 2 (on problems related to the goal) on a single test or the final exam.
- **Mastering** a learning goal means getting an average of 3 (on problems related to the goal) on a single test or the final exam.

Homework and quizzes are also grouped together, separately from the tests and the final exam. Again, passing a goal on an assignment means getting an average of ≥ 2 whereas mastery means an average of 3.

A few remarks about mastery:

1. Mastery on homework or a quiz does not imply mastery on a test or the final exam.
2. Once you have demonstrated mastery of a learning goal on a test, you do not need to continually show mastery in it on other tests or the final exam. For example, if you get a 3 on the problems on the first test related to **IVP**, then you do not need to answer problems related to **IVP** on later tests.
3. The same applies to learning goals on homework and quizzes: you still need to show mastery on tests, but mastering it on the homework means you don't need to show mastery on other homework or quizzes (although doing so is highly recommended for practice).
4. Nevertheless, sometimes a question will make use of multiple learning goals in a single question or part of a question, so if you haven't mastered **FOSE** but have mastered **IVP**, then you should still answer a question that is related to both **FOSE**, **IVP**.

5. Mastering or passing a learning goal on a test only requires doing so on *one* test or the final exam. So if you miss a problem on, say, the first test, you could still master it on the next. The same applies to learning goals on homework and quizzes.
6. There are certain *core* objectives that you need to pass the course: **IVP**, **Eig**, **Mod**, **Term**, and **FOSE**. *Questions related to these must be answered on the final exam regardless of previous mastery.*
7. Test and quiz questions will be marked with what learning goals they are related to.
8. Homework will be marked with the learning goals, but the individual questions will not; you are expected to be able to recognize what goals are required.

The only outlier here is the MATLAB learning goal, which only considers the MATLAB assignments. *Passing* MATLAB requires getting 70% of the points on the MATLAB assignments. *Mastering* MATLAB requires getting 85%.

§ 10. Your Course Grade

At the end of the course, the final course grade will be given by the number of mastered and passed goals on tests/the final exam and homework/quizzes. With more goals passed and mastered, the better you do in the course.

Consider the following table.

	Number of Learning Goals Required on Tests/Exam		Number of Learning Goals Required Overall	
Preliminary Grade	Mastered	Passed	Mastered	Passed
A	21	23	22	24
B	18	21	21	23
C	15	18	18	21
D	12	15	16	19

Using this table, you will receive a grade for learning goals on tests, and a grade for learning goals *overall* (meaning passing or mastering on any assignment, not just tests or the final exam). Your final grade will be the average of those two preliminary grades.

- For example, an A and a B gives a $B+$.
- Note you must meet *both* of the requirements of a letter grade to receive it.
  - Suppose on tests you master 14 and pass 24.
  - You have not met the required 15 mastered on tests for the preliminary grade of C on tests, but have met the requirements for a D. You have far surpassed the required number of passed for a D, but you haven't met both requirements for the higher grades.
- Another example, mastering 18 and passing 20 on tests/the final exam (a C), and mastering all 24 overall (an A) yields a final grade of B.

Getting anything less than the requirements of a D means receiving an F.

In addition, to pass the course, you must pass each of the following learning goals on the final.

1. (**IVP**) Initial Value Problems;
2. (**Eig**) Eigenvalues and Eigenvectors;
3. (**Mod**) Modelling Systems;
4. (**Term**) Classification, Graphs, and Terminology; and
5. (**FOSE**) Separable Equations.

You must answer all questions related to these on the final exam and your mastery is reevaluated then: to pass, you must earn at least an average of ≥ 2 on those problems.

§ 11. Review of Learning Goals and Grading

To sum up, there are 24 learning goals, listed in Section 7. Questions are graded on a scale from 0–3 with 2 representing "passing" and 3 representing "mastery".

- Mastering a goal on a test means you don't need to master it on another test, and similarly for passing.
- Mastering a goal on a quiz or homework means you don't need to master it on another quiz or homework, and similarly for passing. You still should pass it on a test.
- The number of goals passed/mastered on tests, and passed/mastered overall each has a letter grade associated with it. Your grade will be the average of those.
- You need to pass **IVP**, **Eig**, **Mod**, **Term**, and **FOSE** to pass the course, and you must answer all questions related to these on the final exam (which will determine whether you pass these learning goals) regardless of whether you mastered them before.
- Quizzes, homework, and tests are graded by averaging the question grades out of 3 and rounding.
- Passing MATLAB requires getting 70% of the points on the MATLAB assignments, and mastering MATLAB requires getting 85%.

§ 12. Course Policies

It's impossible to physically sit down and explicitly write out every little detail about what is not allowed: one must be vague, incomplete, or both. I will be both here with the following guidelines about conduct.

- Don't be mean, hateful, etc.
- Generally follow the ideas of Section 5.
- Don't cheat. Be familiar with the academic integrity policy located here. Violations of this policy are taken very seriously.
- Let me know if you think you're going to be late with an assignment or miss a class. I know things happen, so let me know beforehand. If the excuse is serious enough and unavoidable, you won't be penalized even if you let me know afterward (assuming you let me know promptly enough). What counts as "serious"? Well, that's decided on a case-by-case basis. It never hurts to let me know about your situation, and I encourage you to.
- Be on time. Yes the lectures are recorded, but it's important to participate and be able to communicate mathematical ideas. You aren't doing that by watching a video in your bed at $\times 2$ speed.
- Paper submissions (e.g. for homework) should be submitted in the .pdf or .doc file formats.
- Send me an email with the phrase "Wow, I read most of the syllabus" in the subject line, and I'll give you extra credit.
- During tests and the final, you must have your camera on and pointed at a reasonable angle, and have your microphone turned on. You may not use a calculator nor a phone. You must show your work and upload it. I recommend using some sort of scanning application like Adobe Scan, Microsoft Lens, CamScanner, etc.
- You must follow the technology recommendations of Rutgers listed here, which mostly consist of a decent internet connection, a browser that works with Canvas, a webcam, and a microphone.
- Make-ups to tests may be given on a case-by-case basis assuming you let me know beforehand.

Note that all of this is subject to change. I'll post an announcement if there are any changes.

§ 13. Proctored Examinations

Tests and the final exam will take place on BigBlueButton on Canvas. During tests and the final exam,

- You should have a camera on, and pointed at a reasonable angle (e.g. at your hands or workspace).
- Your microphone and computer's speakers should not be muted.
- You must show your work. You may not use a calculator nor a phone.
- If you want to ask a question, please use the chat box to directly message me rather than the whole class.

- You must stop working at the end of the given test or exam period and use the remaining time to submit your work. I recommend using some sort of scanning application like Adobe Scan, Microsoft Lens, CamScanner, etc.

§ 14. Out of Class Resources

There are a number of campus resources to help you. I will try my best to be someone you can lean on in some ways, but I am not be equipped to deal with everything.

- **CAPS (Counseling, Alcohol and Other Drug Assistance Program & Psychiatric Services)** - (848) 932-7884 with website here - CAPS offers mental health help. When you call, you don't have to give them your info; you can do it anonymously. Being afflicted with conditions like depression is serious, regardless of whether you have a "clinical" diagnosis, and unfortunately, many conditions can be made worse with the added stress of an intensive class. *Please* seek help through them if possible.
- **The Office of Violence Prevention and Victim Assistance** - (848) 932-1181 with website here and here - This office can help if you are a victim of abuse or violence including counselling , navigating legal systems, or even just going with you to a hospital or rape crisis center. Every student should know about this if it helps protect other students.
- **SJE (The Center for Social Justice Education and LGBT Communities)** - website here - Having this sort of community can be important to many students. This provides a lot of events and organizations that allow you to get involved, be supported, and become a part of a community.
- **Accessibility Accommodations** - website here and here - If you have a disability that needs (or you'd like) accommodation, please contact ODS (Office of Disability Services) to discuss what the appropriate course of action should be. The idea is that they'll give you a letter of what accommodations I should give.

Generally, there is also Rutgers' list of resources here.

§ 15. Schedule of the Course

The following details the schedule of the course week by week, listing what sections are covered in class, what quizzes you are assigned each day, and when homework is due. Tests are usually given at the end of the week. Not every date between the start of the class and the end is listed (e.g. most weekends). Also, things are a little wonky at the end with due dates since there is a hard cut-off line for the course.

Week 1

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-06-27		Introduction, 1.1, 1.2	Background Quiz 1 §1.1 - Quiz 1 §1.2 - Quiz 1	
2022-06-28		MATLAB Workshop 1, 1.5, 1.3	Background Quiz 2 §1.5 - Quiz 1	
2022-06-29		1.3, 1.4	§1.1 - Quiz 2 §1.3 - Quiz 1	Homework 1 MATLAB Assignment 1
2022-06-30		1.4, 1.7	§1.3 - Quiz 2 §1.4 - Quiz 1 §1.7 - Quiz 1	
2022-07-01				Homework 2

Week 2

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-07-04	No class			
2022-07-05		1.8	§1.2 - Quiz 2 §1.8 - Quiz 1	
2022-07-06		1.6, 1.9	§1.5 - Quiz 2 §1.6 - Quiz 1 §1.8 - Quiz 2	Homework 3
2022-07-07	**FIRST TEST**		**FIRST TEST**	
2022-07-08				
2022-07-09				MATLAB Assignment 2

Week 3

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-07-11		2.1	§2.1 - Quiz 1	
2022-07-12		2.2	§1.3 - Quiz 3 §2.1 - Quiz 2 §2.2 - Quiz 1	
2022-07-13		2.3, 2.4	§2.2 - Quiz 2 §2.3 - Quiz 1 §2.4 - Quiz 1	Homework 4
2022-07-14		2.4, 2.5	§1.1 - Quiz 3 §2.3 - Quiz 2 §2.5 - Quiz 1	
2022-07-15				Homework 5 MATLAB Assignment 3

Week 4

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-07-18		2.5, 2.6	§1.7 - Quiz 2 §2.4 - Quiz 2 §2.6 - Quiz 1	
2022-07-19		2.7, Workshop	§1.4 - Quiz 2 §2.5 - Quiz 2 §2.6 - Quiz 2	Homework 6
2022-07-20	**SECOND TEST**		**SECOND TEST**	
2022-07-21		3.1, 3.2, 3.3, MATLAB Workshop 2	§1.2 - Quiz 3 §3.1, 3.2 - Quiz 1 §3.3 - Quiz 1	
2022-07-22				Homework 7

Week 5

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-07-25		3.3, 3.4	§3.1, 3.2 - Quiz 2 §3.3 - Quiz 2 §3.4 - Quiz 1	
2022-07-26		3.3, 3.5	§1.4 - Quiz 3 §3.4 - Quiz 2 §3.5 - Quiz 1	Homework 8
2022-07-27		3.5, 3.6	§1.5 - Quiz 3 §3.5 - Quiz 2 §3.6 - Quiz 1	
2022-07-28		4.1, 4.2	§2.2 - Quiz 3 §3.6 - Quiz 2 §4.1 - Quiz 1	MATLAB Assignment 4
2022-07-29				
2022-07-30				Homework 9

Week 6

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-08-01		4.3, 4.4	§2.1 - Quiz 3 §4.1 - Quiz 2 §4.3 - Quiz 1	
2022-08-02		4.4	§1.4 - Quiz 4 §4.3 - Quiz 2 §4.4 - Quiz 1	Homework 10 MATLAB Assignment 5
2022-08-03		4.4, Workshop	§3.6 - Quiz 3 §4.3 - Quiz 3 §4.4 - Quiz 2	
2022-08-04	**THIRD TEST**		**THIRD TEST**	

Week 7

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-08-08		4.5, MATLAB Workshop 3	§1.6 - Quiz 2 §1.7 - Quiz 3 §2.3 - Quiz 3	
2022-08-09		4.5	§3.3 - Quiz 3 §4.4 - Quiz 3 §4.5 - Quiz 1	MATLAB Assignment 6
2022-08-10		4.6	§2.5 - Quiz 3 §4.5 - Quiz 2 §4.6 - Quiz 1	Homework 11
2022-08-11		5.1	§1.2 - Quiz 4 §4.6 - Quiz 2 §5.1 - Quiz 1	
2022-08-12				Homework 12

Week 8

Date	Event	Sections Covered	Quizzes Due	Homework Due
2022-08-15		5.2, 5.3	§5.1 - Quiz 2 §5.2 - Quiz 1	
2022-08-16		5.2, 5.3	§4.6 - Quiz 3 §5.1 - Quiz 3 §5.2 - Quiz 2	Homework 13
2022-08-17	**FINAL**		**FINAL**	