Ordinary Differential Equation
Syllabus

MTH 321 Sections B & C
Spring 2024
University of Portland

Contents

MTH 321

About the Class

Course Information

- Title: Ordinary Differential Equation
- Sections: B & C

Instructor Information

- Instructor: Dr. Alex John Quijano
- Office: Buckley Center 279
- Email: quijano@up.edu

Prerequisites

MTH 202 with a grade of C- or higher or permission of instructor.

Lectures and Discussions

In-person lectures and discussions will occur synchronously during their scheduled time on Tuesday, and Thursday. Our lectures will typically consist of traditional lectures in the first 20 to 30 minutes of class, then followed by a mini-activities in a form of group work, discussions, or worksheets.

The course schedule and location is:

- **Section B:** TuTh 11:20 AM - 12:45 PM, Dundon-Berchtold Hall 230
- **Section C:** TuTh 2:30 PM - 3:55 PM, Buckley Center 104

Recommended Textbooks

This course uses the following two textbooks - which is free to access - for optional reading and practice.

Click on the link to access the resources.

- Hallstrom C (2018). *Ordinary Differential Equations: A Primer on, Dynamics and Systems*. online. Version 2.3. [pdf]
- Trench WF (2013). *Elementary Differential Equations*. Faculty Authored, and Edited Books & CDs. 8. [pdf]

Communication Tools

Class Website

The syllabus, tentative topics schedule, assignments, and all other class materials are posted on the course website.

> You can access the course website at mth-321bc-sp24. The website can also be viewed in Teams.

Microsoft Teams

We will be using Teams as the main real-time communication tool for general announcements, assignment submissions, question-answering discussions, and direct messages. I added you to the Teams page already, so you just need to log in using your UP credentials. If not, then send a request when you log in. Let me know if you need any assistance.

> The Teams for this course is MTH-321BC-sp24.

Email

My UP email is quijano@up.edu.

> If you prefer communicating through email, note that I have set up an email filter for this course, and you must put the "MTH 321" keyword in your subject line.

It is easy for me to get notice of your email if you put the keyword in the subject line. Concise and specific messages are helpful, so I know how I can best help you.

Assignment Tools

Gradescope

All assignments and feedback must be submitted through Gradescope. You are already listed in Gradescope for this course using your UP email. The gradescope website can also be access through Teams.

> Please register on Gradescope using your UP email address to access assignments. The Gradescope entry code for this course is **VB7G66**.

Note that you may submit your assignments physically in-person if you prefer. I will scan and upload your assignments to Gradescope.

Computing

We will be using a computational tool in some assignments. These tools are free and open-source.

> R or Python instructions and materials will be provided ad hoc.

Learning Goals

Description

This course explores ordinary differential equations (ODEs) and their practical applications, providing students with a solid understanding of 1st- and 2nd-order linear equations, systems of linear equations, and their relevance in modeling various physical phenomena. Additionally, the course covers basic numerical methods for ODEs. Beyond exploring fundamental concepts, the course emphasizes qualitative analysis techniques such as direction fields and phase portraits, offering valuable

insights into the behavior of ODEs. Structured for students with an interest in both theoretical underpinnings and real-world applications of ODEs, the course is beneficial for those pursuing majors in mathematics, engineering, physics, biology, or other scientific disciplines. Whether aspiring to unravel the intricacies of mathematical theory or apply ODEs to solve complex problems in diverse fields, this course equips students with essential knowledge and skills for a solid foundation in ordinary differential equations.

Learning Outcomes

By the end of the semester, you will be able to:

- Understand the basic concepts of ordinary differential equations (ODEs).
- Understand the basic concepts of 1st-order system of ODEs.
- Analyze the qualitative behavior of solutions around equilibriums of linear and non-linear ODEs.
- Solve first- and second-order linear ODEs which includes initial and boundary value problems.
- Solve first-order linear system of ODEs which includes initial value problems.
- Use a basic numerical method to solve ODEs.
- Apply ODEs to model physical phenomena.
- Write clear and concise mathematical solutions to ODE problems.
- Communicate effectively about ODEs with other students, instructors, and professionals.
- Work independently and as part of a team to solve ODE problems.

Learning Objectives

Upon completion of the course, you will be able to:

- Define ordinary differential equations (ODEs) and their basic structure, such as order, linearity, homogeneity, and autonomy.
- Define a 1st-order system of ODEs and their basic structure, such as, linearity, homogeneity, and autonomy.
- Use direction fields and phase portraits to analyze the qualitative behavior of solutions around equilibriums of linear and non-linear ODEs.
- Use separation of variables, integrating factors, and Laplace transforms to solve 1st-order linear ODEs.
- Use undetermined coefficients, variation of parameters, and Laplace transforms to solve 2nd-order linear ODEs.
- Use algebraic and eigentheory methods to solve 1st-order linear system of ODEs.
- Use Euler's Method and Runge-Kutta method to numerically solve ODEs.
- Apply ODEs to model physical phenomena, such as population dynamics, fluid mechanics, and harmonic oscillators.

Academic Support

Help Hours

Dr. Alex John Quijano

- Walk-in Monday to Thursday at 4:00 PM - 5:00 PM, Buckley Center 279
- One-to-One, Buckley Center 279 or in Teams *Click on the link to sign-up for a 15-minute session.*

My walk-in help hours start week 2. Note that you can bring a fellow student with you when you sign-up for a session. Just click the "Add Guests" link when you sign-up, and add in your fellow student's UP email. If you need more than 15 minutes, you can book at least two consecutive sessions.

The Learning Commons

Students can get academic assistance through Learning Commons tutoring services and workshops. The Co-Pilot peer tutoring program provides students with opportunities to work with other students to get help in writing, math, group projects, and other courses. Schedule an appointment to meet with a Co-Pilot (tutor) by visiting the Learning Commons website. Students can also meet with a Co-Pilot during drop-in hours. Check the Learning Commons website or drop by the Learning Commons in BC 163 to learn more about their services. Find a tutor at the Learning Commons to get support on your academic journey.

Math Resource Center

Appointment-based tutoring accepts appointments starting week 1 and sessions start week 2. Visit the Math Resource Center website to sign-up for an appointment. Drop-in tutoring is Monday to Thursday, 3:00 PM - 7:00 PM in BC 163 and starts week 2. Check the Math Resource Center website or drop by the center for more information.

Help Hours Guidelines

It is strongly recommended that you attend the walk-in help hours or set up a one-to-one meeting with the me if you feel like you are falling behind during our in-person class activities, or if you just need to clarify concepts discussed in class. In order to be more productive during a one-to-one meeting (or the walk-in help hours), these are three recommendations before you come in:

- List all gaps in knowledge you have (missed concepts) or list all concepts that were unclear to you during class. We will address them one by one.
- Prepare questions you want answered and be ready to show relevant materials.
- Regarding assignments, prepare to show (a) what are the steps you have tried and (b) what are the errors you encountered and the strategies you have tried.

Note that these are recommendations so that you can get the most out of the help hours allocated for you. If you just want to come in and chat about something else, feel free to do so. If the dedicated time for one-to-one meeting does not work for you, send me a message to set up an appointment.

Collaboration Policy

I expect you to participate in the class through lectures, discussion, labs, and other engagements. I also expect you to make use of opportunities to get help outside of class (help hours, Teams, email, tutoring) if you need help. Concise and specific messages are the most helpful so I know how I can best help you.

Students are encouraged to participate in discussions with their peers (or each other) regarding homework and other assignments. However, each student must take responsibility and ownership of their work and submit their work individually.

Assessment

Assessment Disclosure Statement

Student work products for this course may be used by the University for educational quality assurance purposes.

Standards-Based Grading

Learning mathematics takes hard work, thinking what you have learned, and making changes to your understanding. Students will be assessed on their proficiency in mathematics, and they will have opportunities to demonstrate their proficiency, revise their work and reflect on their learning.

This course follows the standards-based grading system which focuses on the mastery of specific learning standards. It is more accurate and motivating than traditional grading systems, and can help to create a more equitable learning environment. Here are some of the key features of this type of grading:

- Focuses on mastery of specific learning standards
- Uses a variety of assessment methods
- Provides feedback to students on their progress
- Helps students to set goals and track their progress

Grading

Each assignment will be graded according to the general grading guide detailed below. Each student will be given feedback on their assignment and learning process to improve their performance. Note that each assignment has its own rubric guided by these general guidelines and the assignment's learning objectives.

Given the following categorical grade, the student's work is able to:

Grade	Rubric Description
Outstanding (O)	Demonstrate full understanding of material, clearly and concisely explains concepts, applies them to solve problems correctly and efficiently, and may extend concepts to new situations.
Excellent (E)	Show approximate understanding of material, may have made minor errors but can correct them and explain reasoning, solves problems correctly, and may need more time or practice for efficiency.
Acceptable (A)	Show some understanding of material but makes errors, can solve some problems, may need help with more difficult ones, need to work on problem-solving skills and reasoning needed.
Needs Improvement (NI)	Show potential but needs more work, made a lot of errors or unable to solve any problems, need to work on understanding material and problem-solving skills.
Needs Major Improvement (NMI)	Little understanding of material and some parts are incomplete or missing. Made many errors, unable to solve any problems, need to work on understanding material from the ground up.
Incomplete (I)	No work submitted or blank.

Note that these are categorical grades (not scores)

Final Grades

Assignment	Rank	Grade	A	B	C	D
Exams	1	O	70%	-	-	-
		E	-	60%	-	-
		A	-	-	50%	-
		NI	-	-	-	40%
Homeworks	2	O	100%	-	-	-
		E	-	90%	-	-
		A	-	-	80%	-
		NI	-	-	-	70%
Worksheets	3	Completed	90%	80%	70%	60%

The above table shows the percent of given assignments. These percentages are minimum requirements for each letter grade. The rank determines the importance of each assignment where 1 means high rank and 3 means low rank.

The percentages in the table are not set in stone. I will evaluate your overall performance, including your self-assessments, when making decisions. I will never raise the standards outlined in the table, but I may round down the minimum percentages to help you succeed.

Decisions about +/- cutoffs will be based on two things: your performance on the final exam and your overall achievements.

Assignments

Submission Guidelines

You can submit your assignments physically or online through Gradescope. If you decide to submit online, your work can be hand-written or typed, but must be uploaded as a single pdf file. If you had handwritten your answers/solutions on a physical paper, make sure to label it properly and please scan your document using a scanner app for clarity. Suggestions: "Adobe Scan" for Android or iOS.

Worksheets

There will be worksheets for each non-exam week. The purpose of the worksheets is for in-class group work and activities. The group members must submit their completed worksheet individually by end-of-class or end-of-day. Worksheets are graded mostly on completion, and partially on correctness. Your name must exist in your worksheet and the names of your collaborators.

Homeworks

Homework is assigned every week and due every Friday by end-of-day, except for exam weeks. You must do and submit your homework individually. Homework is graded mostly on correctness and completion.

Homework Revisions

You can revise your homework for an up-grade, meaning - for example - a grade of "NI" can be up-graded to "A".

Here are the qualifications and requirements for homework revisions:

- A homework grade of "NMI", "NI", "A", or "E".
- You must submit homework on time.
- The homework to be revised must be completed, meaning all parts should have your full written solutions. Incomplete homework is disqualified for revisions, but you can still use them as practice.
- A complete written revisions of the parts with errors in your homework.

Here are the rules for homework revisions:

- Homework revisions are accepted within one week of the homework being returned to you, otherwise the grade is set.
- Late revisions are not accepted unless the instructor allows.

Exams

Exams are given in two parts which are in written and oral forms. Below are the description of each part of the exams.

Written The written part of the exam allows you demonstrate your understanding of the material in written form. This part will be evaluated on the details of your computations and solutions.

Written exams will be graded on 3 components:

Written Component	Description
Methodology	The method should be sound and well-founded. It should be based on a solid understanding of the underlying principles. The method should be applied correctly and consistently.
Reasoning	The solution method should be explained in a clear and logical way. The steps of the method should be justified and explained. The reasonableness of the solution should be justified.
Writing	The solution process should be written in a clear and concise way. The steps of the method should be easy to follow. The graphs/diagrams/equations should be clear and helpful. The mathematical notation should be used clearly and correctly.

Here are the rules for the written part of the exams:

- Written exams are take-home exam and given 24 hours before exam days.
- Written exams are due on exam days.
- Late submissions are not accepted unless the instructor allows.

Oral The oral part of the exam allows you to demonstrate your understanding of the material verbally. It is administered mostly in dialog style during exam days. The oral exam is only ten to fifteen minutes and it consists of one problem similar to the written exam with added questions from me. This part will be evaluated on your ability to explain key concepts and navigate through different ways to solve problems, rather than detailed solutions.

Oral exams will be graded on 3 components:

Oral Component	Description
Knowledge	This includes the student's ability to recall and apply mathematical concepts and procedures. The student should be able to answer questions about the material in a clear and concise way, and they should be able to solve problems using a variety of methods.
Communication	This includes the student's ability to explain their thinking clearly, concisely, and timely. The student should be able to use mathematical language fluently, and they should be able to communicate their ideas in a way that is understandable.
Problem-solving	This includes the student's ability to identify and solve mathematical problems. The student should be able to think critically about problems, and they should be able to develop and implement strategies for solving them.

Here are the rules for the oral part of the exams:

- You must sign-up for a time slot on exam days 24 hours in advance.
- You must submit your written exam at the beginning of the oral exam.
- You may have all other resources with you during the oral exam, that includes books and online resources.
- You may not communicate with others during the exam except to me.
- You may not ask conceptual questions to the examiner except for clarifying questions about the problem, and minor computations.

The grade you will receive for exams are a breakdown of your written and oral exam results with detailed feedback.

Here is how you can sign-up for the exam (oral part):

- ODE Exam (Oral Part) Sign-Up *Click on the link to sign-up for a 15-minute session.*

Exam Retakes

Your exams can be revised and you can retake both written and oral parts. Exam retakes allows you to have your exams up-graded, meaning - for example - a grade of "NI" can be up-graded to "A".

Exam retake procedure are similar to the original exam. The written part is your revised exam and the oral part is explaining your revisions and responding to feedback from the last oral exam.

Here are the qualifications for exam retakes:

- An exam grade of "NMI", NI", "A", or "E".
- The exam to be revised must be completed, meaning all parts should have your full written solutions. Incomplete work is disqualified for revisions and retakes.
- A complete written revisions of the parts with errors in your exam.

Here are the rules for exam retakes:

- Exam retakes must be done within one week of the exam being returned to you, otherwise the grade is set.
- If you need to retake an exam more the one week of the exam being returned to you, let me know for a discussion.
- The same written and oral exam part rules apply for exam retakes.

Here is how you can sign-up for the exam (oral part) retakes:

- ODE Exam (Oral Part) Retakes *Click on the link to sign-up for a 15-minute session.*

Make-up Exams

You can make-up exams due to extenuating circumstances. Please let me know if you can't make it to an exam day. If you missed an exam day, please let me know as soon as possible to discuss the next steps.

Here are the rules of make-up exams:

- A missed exam day means that you will automatically receive a grade of "I" for that particular exam.
- Make-up exams by appointment must be scheduled 24 hours in advance.
- Make-up exams must be done within two weeks of the original exam day.

  Here is how you can sign-up for the exam (oral part) make-ups:

  - ODE Exam (Oral Part) Make-Ups *Click on the link to sign-up for a 15-minute session.*

Final Exam

The final exam includes the written and oral parts. This exam will be cumulative. Makeup exams are not allowed during finals week. The same written and oral exam part rules apply for the final exam, except that retakes are no longer allowed.

The final exam is on:

- **Section B:** April 30, Tu 1:30 PM - 3:30 PM, Dundon-Berchtold 230
- **Section C:** May 2, Th 10:30 PM - 12:30 PM, Buckley Center 104

Expectations

Appointment Cancelation Policies

You can cancel your appointments, but it is strongly recommended that you cancel 12 hours before your scheduled time so that other students can schedule when a spot opens. You can reschedule for a different day and time if you need to.

Please try to show-up to any of your appointments. If you have extenuating circumstances, please let me know as soon as possible to discuss next steps.

Attendance and Participation

Attendance is not tracked. However, participation is highly recommended. You are expected to actively participate in this class. Participation includes coming to class on time, being prepared, being willing to ask questions and share ideas, setting up study groups outside of class, attending tutoring sessions, posting helpful resources online, and contributing to the Teams discussion channels. Group and individual presentations of ideas is a suggested component of participation.

Absences

Generally, students are expected to attend all class sessions according to the instructor's direction. Students who feel unwell should NOT attend class in person. These students should inform their instructor as soon as possible.

Should the instructor need to miss class, the course may be temporarily conducted remotely. Should the instructor be unable to teach for an extended period of time, the respective department or unit will find a substitute to continue the course.

Late Assignments and Incompletes

You are expected to turn in all completed assignments on time. Circumstances that may disallow you to turn in your work on time - such as a medical reason - are understandable. Please let the instructor know if you are unable to submit your work and have missed the deadline way beyond its original posted date. Because every assignment is an important aspect of your learning in this class, we will discuss when you will turn in the assignment as well as decide upon an acceptable consequence for your turning it in late. I am committed to successfully helping you learn from this course.

Diversity, Equity, and Inclusion Statement

In the study of natural and mathematical sciences, often perceived as objective disciplines aimed at understanding the world, it is crucial to recognize the historical biases embedded within these fields, stemming from a limited set of privileged populations. Acknowledging the potential existence of overt and covert biases within the course, I emphasize that science is a human endeavor necessitating the incorporation of diverse experiences in the pursuit of knowledge and skill. Valuing every student irrespective of background, origin, race, religion, ethnicity, sexual orientation, disability status, etc., I am committed to fostering an inclusive climate throughout the course. Encouraging open communication about concerns or challenges, I assure confidentiality, except for instances of academic integrity violations or sexual harassment, which are legally mandated to be reported. Within our classroom, diversity and individual differences are celebrated as strengths, and the use of mathematics as an analytical tool to challenge power, privilege, and oppression is supported. It is our collective responsibility to create a welcoming space where ideas can be challenged while maintaining respect for individuals.

Accessibility Statement

The University of Portland strives to make its courses and services fully accessible to all students. Students are encouraged to discuss with their instructors what might be most helpful in enabling them to meet the learning goals of the course. Students who experience a disability are also encouraged to use the services of the Office for Accessible Education Services (AES), located in the Shepard Academic Resource Center (503-943-8985). If you have an AES Accommodation Plan, you should meet with your instructor to discuss how to implement your plan in this class. Requests for alternate location for exams and/or extended exam time should, where possible, be made two weeks in advance of an exam, and must be made at least one week in advance of an exam. Also, if applicable, you should meet with your instructor to discuss emergency medical information or how best to ensure your safe evacuation from the building in case of fire or other emergency. All information that students provide regarding disability or accommodation is confidential. All students are responsible for completing the required coursework and are held to the same evaluation standards specified in the course syllabus.

Code of Academic Integrity

The University of Portland is a diverse academic community of learners and scholars who are dedicated to freely sharing ideas and engaging in respectful discussion of those ideas to discover truth. Such pursuits require each person, whether student or faculty, to present truthfully our own ideas and give credit to others for the ideas that they generate. Thus, cheating on exams, copying another student's assignment, including homework, or using the work of others without proper citation are some examples of violating academic integrity.

Especially for written and oral assignments, students have an ethical responsibility to properly cite the authors of any books, articles, or other sources that they use. Students should expect to submit assignments to Turnitin, a database that ensures assignments are original work of the student submitting. Each discipline has guidelines for how to give appropriate credit, and instructors will communicate the specific guidelines for their discipline.

The use of artificial intelligence (AI) tools such as ChatGPT without attribution also constitutes plagiarism. Students must cite any AI-generated text and ideas and disclose any activities (e.g. brainstorming, editing, translating, etc.) for which AI was employed. Students are expected to demonstrate sound judgment in discerning when and how to utilize AI ethically across their academic work, upholding standards of citation, originality, and integrity. The misuse of AI to shortcut academic requirements will be considered a breach of academic integrity. Students who have questions about when and how to use AI should talk with their instructor.

Referencing and Citation Guidelines

In your written work for this course, you must cite all sources of information that you use, whether they are direct quotes, paraphrases, or summaries. The style of citation that you use should be consistent throughout your paper. The citation styles for this course are APA or CSE.

- APA style is used in the social sciences and psychology. It is characterized by parenthetical citations that include the author's last name and the year of publication. For example, "According to Smith (2023), the average height of a man in the United States is 5'10"."

- CSE style is used in the natural sciences and engineering. It is characterized by numbered citations that are listed at the end of the paper. For example, "[1] Smith, J. (2023). The average height of a man in the United States. Journal of Human Biology, 55(2), 123-132."

If you are unsure which citation style to use, please consult with me. You can also find more information about APA and CSE style in the Clark Library citation guidelines: libguides.up.edu/cite

Plagiarism is the act of using someone else's work without giving them credit. It is a serious academic offense that can result in a failing grade or even expulsion from school. By following these guidelines, you can help to avoid plagiarism and ensure that your work is properly cited.

Mental Health Statement

Anyone may sometimes experience problems with their mental health that interfere with academic experiences and negatively impact daily life. If you or someone you know experiences mental health challenges at UP, please contact the University of Portland Wellness Center in the lower level of Orrico Hall (down the hill from Franz Hall and near Mehling Hall) at 503-943-7134 or wellness@up.edu. Their services are free and confidential. In addition, confidential phone counseling is available at the Pilot Helpline by calling 503-943-7134 and pressing 3. The University of Portland Campus Safety Department (503-943-4444) also has personnel trained to respond sensitively to mental health emergencies at all hours. Remember that getting help is a smart and courageous thing to do - for yourself, for those you care about, and for those who care about you.

Non-Violence Statement

The University of Portland is committed to fostering a safe and respectful community free from all forms of violence. Violence of any kind, and in particular acts of power-based personal violence, are inconsistent with our mission. Together, all UP community members must take a stand against violence. Learn more about what interpersonal violence looks like, campus and community resources, UP's prevention strategy, and what we as individuals can do to assist on the Green Dot website, www.up.edu/greendot. Further information and reporting options may be found on the Title IX website, www.up.edu/titleix.

Ethics of Information

The University of Portland is a community dedicated to the investigation and discovery of processes for thinking ethically and encouraging the development of ethical reasoning in the formation of the whole person. Using information ethically, as an element in open and honest scholarly endeavors, involves moral reasoning to determine the right way to access, create, distribute, and employ information, including: considerations of intellectual property rights, fair use, information bias, censorship, and privacy. More information can be found in the Clark Library's guide to the Ethical Use of Information at libguides.up.edu/ethicaluse.

Tentative Topics Schedule

See Books & Online Resources Lists for the readings & practice materials.

The reading materials are not mandatory but it is encouraged.

The "Reading" column in the table below contains page numbers on which it refers to a label in the Books & Online Resources List. For example "Pgs. 1-5 [H]" refers to pages 1-5 of the first item in the list, which is the textbook titled "Ordinary Differential Equations: A Primer on Dynamics and Systems".

Topics and Materials

Week	Day	Topic	Activity	Homework	Reading
1	Tu 1/16	Introduction and Orientation to ODES, Classification of Equations, & Principles of Solutions	Algebra & Calculus Review	Assigned: Homework 0	Syllabus
	Th 1/18	1st-Order ODEs, Modeling Physical Processes, & Existence and Uniqueness	TBA	-	TBA
2	Tu 1/23	Analyzing Equilibriums of Linear and Non-Linear 1st-Order ODEs	TBA	Assigned: Homework 1	TBA
	Th 1/25	Bifurcations in One Dimension	TBA	-	TBA
3	Tu 1/30	Separation of Variables for Solving 1st-Order ODEs	TBA	Assigned: Homework 2	TBA
	Th 2/1	Integrating Factors for Solving 1st-Order ODEs	TBA	-	TBA
4	Tu 2/6	Laplace Transforms	TBA	Assigned: Homework 3	TBA
	Th 2/8	Laplace Transforms for Solving 1st-Order ODEs	TBA	-	TBA
5	Tu 2/13	*Review*	Exam 1 Examples	-	Exam 1 Guide
	Th 2/15	**Exam 1**	-	-	-
6	Tu 2/20	Systems of 1st-Order ODEs, Modeling Physical Processes, & Existences and Uniqueness	TBA	Assigned: Homework 4	TBA
	Th 2/22	Analyzing Equilibriums to 1st-Order Linear and Non-Linear Systems	TBA	-	TBA
7	Tu 2/27	Linear Transformations & Eigentheory	TBA	Assigned: Homework 5	TBA
	Th 2/29	Stability Analysis of 1st-Order Linear Systems	TBA	-	TBA
8	Tu 3/5	*Spring Vacation*	-	-	-
	Th 3/7	*Spring Vacation*	-	-	-
9	Tu 3/12	Bifurcations in Two Dimensions	TBA	Assigned: Homework 6	TBA
	Th 3/14	Eigenvalues and Eigenvectors for solving 1st-Order Linear Systems	TBA	-	TBA
10	Tu 3/19	*Review*	Exam 2 Examples	-	Exam 2 Guide
	Th 3/21	**Exam 2**	-	-	-
11	Tu 3/26	Higher Order ODEs, Modeling Physical Processes, & Characteristic Equations	TBA	Assigned: Homework 7	TBA

Week	Day	Topic	Activity	Homework	Reading
	Th 3/28	Analyzing Linear and Non-Linear 2nd-Order ODEs	TBA	-	TBA
12	Tu 4/2	Undetermined Coefficients for Solving Linear 2nd-Order ODEs	TBA	Assigned: Homework 8	TBA
	Th 4/4	Variation of Parameters for Solving Linear 2nd-Order ODEs	TBA	-	TBA
13	Tu 4/9	Laplace Transforms for Solving Linear 2nd-Order ODEs	TBA	Assigned: Homework 9	TBA
	Th 4/11	Power and Fourier Series Methods for Solving Linear 2nd-Order ODEs	TBA	-	TBA
14	Tu 4/16	*Review*	Exam 3 Examples	-	Exam 3 Guide
	Th 4/18	**Exam 3**	-	-	-
15	Tu 4/23	Euler's Method for Solving ODEs	TBA	Assigned: Homework 10 (Optional)	TBA
	Th 4/25	Runge-Kutta Method for Solving ODEs	TBA	-	TBA
16	Tu 4/30	Final Exam Section B	-	-	-
	Th 5/2	Final Exam Section C	-	-	-

Along with textbooks [H] and [T], and websites [C] and [P], most of the course materials (contents of worksheets and homework) of each topic was taken from these following sources:

- Inquiry oriented differential equations (IODE) by Rasmussen et al. (2018)
- Differential equations and linear algebra by Strang (2014)
- Applied differential equations: The primary course by Dobrushkin (2022)
- Differential Equations by MIT Open Courseware (2015)

Books & Online Resources Lists

Click on the link to access the resources.

Textbooks

[H] Hallstrom C (2018). *Ordinary Differential Equations: A Primer on, Dynamics and Systems*. online. Version 2.3. [pdf]

[T] Trench WF (2013). *Elementary Differential Equations*. Faculty Authored, and Edited Books & CDs. 8. [pdf]

Websites

[C] Clontz S (2022). "Differential Equations - Checkit.", https://stevenclontz.github.io/checkit-clontz-diff-eq.

[P] Dawkins P (2023). "Paul's Online Notes on Differential Equations.", https://tutorial.math.lamar.edu/Classes/DE/DE.aspx.

References

Dobrushkin, V. A. (2022). *Applied differential equations: The primary course* (2nd ed.). Chapman; Hall/CRC.

MIT Open Courseware. (2015). *Differential equations.* https://ocw.mit.edu/courses/res-18-009-learn-differential-equations-up-close-with-gilbert-strang-and-cleve-moler-fall-2015/

Rasmussen, C., Keene, K. A., Dunmyre, J., & Fortune, N. (2018). *Inquiry oriented differential equations: Course materials.* https://iode.sdsu.edu This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. http://creativecommons.org/licenses/by-nc-sa/4.0/

Strang, G. (2014). *Differential equations and linear algebra.* Wellesley-Cambridge Press.