

MATH 240 – Differential Equations COURSE SYLLABUS · FALL 2019

INSTRUCTOR: Roger Griffiths	OFFICE HOURS:
OFFICE: Old Main 305	Mon: 3:00 - 3:50
EMAIL: rgriffiths@mercyhurst.edu	Tues: 08:50 - 09:20 (in Hirt 209)
PHONE: 824-2123	Tues: 1:00 - 1:50
CLASS TIME: Mon, Wed, Fri: 1:00 - 1:50 (3 semester credits)	Tues: 2:00 - 2:50
LOCATION: Hirt 209	Thur: 08:00 - 09:20 (in Hirt 209)
WEB: www.integral-domain.org/rgriffiths/courses/m240/	Thur: 1:00 - 1:50
TEXT: <i>Fundamentals of Differential Equations</i> , (8th Edition) by Nagle, Saff, Snider	

LEARNING OBJECTIVES

In this course you will learn introductory mathematical content of ordinary differential equations and their applications. This will include analytical, qualitative and numerical methods for ordinary differential equations.

Prior to calculus, we used our understanding of the rules of algebra to develop techniques for solving algebraic equations. In this class we will use both the rules of algebra and the rules of calculus (e.g., differentiation shortcuts, integration techniques, etc.) to develop techniques for solving differential equations. We will continue to improve our ability to *write mathematics*.

WHY?

The major application of calculus is posing, solving, and understanding solutions of differential equations. Because many laws of nature are equations involving rates at which quantities change, this idea is a derivative, and equations containing derivatives are differential equations. So, in order to understand the many processes of change in the world, one needs to understand differential equations.

TEXTBOOK

Fundamentals of Differential Equations, by Nagle, Saff, Snider, 8th Edition. You will need this textbook, and be sure to check the edition when purchasing; other editions have similar material, but the assigned problems may be different. Other than a lot of notebook paper and pencils, no other materials are required for this class. You do NOT need to purchase a subscription to MyMathLab or pay to access any other online resources. If you prefer to purchase an electronic version of the text, you're welcome to do so.

CALCULATORS AND COMPUTERS

You may use a calculator/computer to help learn the material, but **you will not be permitted to use a calculator or computer on any quiz or exam.**

There are several portions of the class that will require the use of a computer, however, all of our examinations are carefully designed to be taken "closed book" without the use of calculators or computers. Examination problems will focus on the basic methods and problem solving techniques which every student of differential equations must know without a calculator or textbook. This policy reinforces our stated learning objectives, in particular, furthering our understanding of the language of mathematics. We will be interested in learning and writing mathematics (the process) not in 'the answer'.

HOMWORK

I do not collect or grade your written homework. You will be held accountable for the mastery of homework problems via the quizzes (which can occur any day). As such, you get no credit for *merely attempting the homework*, your goal is independent mastery of each type of problem assigned. The quizzes serve as an immediate assessment of the extent to which you mastered a particular assignment.

HOMWORK SUGGESTIONS

- **Homework is far and away the single most important part of any mathematics course** because this is when most (all) of the learning takes place. Homework problems will be assigned regularly and I expect you to do them. If you are unable to do a problem I expect you to find out how to do it. You have at your disposal several means of meeting this expectation.
 - You can stick with it until you figure it out yourself.
 - You can discuss the problem with a classmate or several classmates (strongly encouraged).
 - You can see me individually during my office hours. I am always happy to talk to you during my office hours or at any other time if not otherwise committed; when coming to my office, be prepared to show me what you've already tried.
 - You can discuss the problem with anyone who can and is willing to help you.
 - You can ask me about the problem in class (time permitting).
- In studying mathematics, you must be careful not to let a tutor or friend *think* for you. It is essential that you can work problems **completely on your own, without help from any resource**, by the time of a quiz or exam.
- Simply ignoring a problem that you are unable to solve is not **acceptable**.
- You should continue to work problems of a given type (even beyond the assigned problems) until you see the pattern yourself, without assistance of any type (i.e. without using your notes, worked examples, or any prior problems).
- Attending every class is not enough; mathematics can only be learned through practice (like anything worth mastering).
- This 'PRACTICE' is how you master the material, you will want to practice in the manner you will be assessed. That means *write mathematics*, your focus should not be on 'the correct answer', but rather, what you write as your solution.

EVALUATION

There will be (almost) regular quizzes, occasional take-home assignments, three exams, and a cumulative final exam. Homework will be assigned but not collected. We will occasionally discuss the homework in class, but students are expected to clear up questions using my office hours. Quizzes and tests will be closed-book and administered in class. In-class quiz problems will be very similar to the assigned homework problems. The final exam will be cumulative (and worth twice a mid-term exam).

Your letter grade in this course will be based on:

- 100 points: **Quizzes** Quiz average out of 100 points, will drop 1 quiz score
- 300 points: **Exams:** 3 exams at 100 points each
- 200 points: **Final Exam** Comprehensive Final exam worth 200 points
- 600 points: **Total points** in the course

And assigned according to the following scale:

Total Class Points	Percent %	Letter Grade	Interpretation
540 - 600	90 to 100	A	Exceptional
522 - 539	87 to 89	B+	Outstanding
480 - 521	80 to 86	B	Very Good
462 - 479	77 to 79	C+	Good
420 - 461	70 to 76	C	Satisfactory
360 - 419	60 to 69	D	Unsatisfactory
0 - 359	Below 60	F	Failure

- ✓ Your overall performance in the course is measured by the total number of points you accumulate relative to the maximum 600 points possible. Your letter grade in this course will be based on the distribution above, the standard scale used in the Mathematics Department.
- ✓ These are the only points possible in this class, there is no extra credit (or 'make up'), your asking for extra credit is a clear indication that you have not read your contract (this syllabus).

COURSE POLICIES

- ✓ You are responsible for all that is announced or covered in class even if you are absent.
- ✓ You are responsible for all the material in a given section unless told otherwise, use the course schedule and suggested homework as a guide.
- ✓ A prerequisite for additional help outside the classroom is regular class attendance.
- ✓ Every student is required to establish a *class contact*, that is, a fellow classmate that you may contact in case you are having a problem with a particular homework exercise at night/weekend or in the event you miss class you can get the class notes from them.
- ✓ If you miss class, you are responsible for getting the notes from your 'class contact' (see above).
- ✓ Email is great for **simple** communications, but more complex issues must be handled in person.
- ✓ Don't use email as an excuse to avoid personal contact.
- ✓ Due to the overwhelming amount of email I receive, any email requests that involve more than a *yes* or *no* response may not get addressed, please come see me in that case.

QUIZZES

- You will be given quizzes regularly (hopefully). Keeping up with the homework, as detailed above, will ensure that you are prepared for the quizzes.
- The quizzes will be based largely on the suggested homework, and should be expected any day (if you are paying attention in class, I generally suggest when the next quiz will occur).
- Everyone is allowed to miss one quiz without penalty (for any reason); thus, there are NO make up quizzes. If you end up taking all of the quizzes, you may drop your low quiz score. Athletes or other individuals missing for school activities are to let me know BEFORE missing the quiz (or it lands above).
- Quiz grades will not be based strictly on whether or not you found the correct answer. Your work must also be written clearly, and with proper notation, to receive full credit.
- The quizzes serve as an immediate assessment of the extent to which you mastered a particular assignment. Good quiz results should serve as positive feedback, but poor quiz results suggest that you must go back and master that material. Repeatedly failing quizzes will almost certainly lead to failing the course, you must take immediate and corrective action if you ever do poorly on a quiz.

EXAMS

- There will be three midterm exams given throughout the semester, in addition to the final exam. The material on the exams will be similar to topics covered on quizzes and homework.
- Students are required to take all exams at the scheduled hour as they appear on the syllabus and course schedule.
- There will be no late 'make-up' exams, as this is unfair to the rest of the class. If you know in advance you are going to miss a scheduled exam, let me know well in advance of the exam; we will work out a time to take it early. Athletes, carefully review our exam schedule looking for conflicts.
- A missed exam will result in the final exam being worth 300 points (you do not lose any points for the missed exam, those points simply roll into the final exam). A second missed exam will receive a grade of 0 (zero).
- Our goal is not simply a 'correct answer'. But rather, you are to demonstrate the extent to which you understand each problem, this means *write mathematics*. A good write-up includes: connecting your work, proper notation, and an explanation of steps as you see necessary.
- Important Dates to Remember:
 - Exam 1: Friday, September 27th.
 - Exam 2: Friday, November 1st.
 - Exam 3: Monday, November 25th.
 - Final Exam: Wednesday, December 11th, 1:00 - 3:00 PM.

SERVICES:

LEARNING DIFFERENCES

In keeping with college policy, any student with a disability who needs academic accommodations must call Learning Differences Program secretary at 824-3017, to arrange a confidential appointment with the director of the Learning Differences Program during the first week of classes.

ADDITIONAL (FREE) RESOURCES

- **Khan Academy Algebra II:** <https://www.khanacademy.org/math/differential-equations>
Introduction to differential equations.
- **Elementary Differential Equations** by William Trench: www.opentextbookstore.com/details.php?id=20
Free textbook by William Trench. This book was published previously by Brooks/Cole Thomson Learning, 2001. This free edition is made available in the hope that it will be useful as a textbook or reference.
- **Wolfram Alpha:** <https://www.wolframalpha.com>
A great way to check your work. Free, with subscription available to access step-by-step solutions to problems.

SUPPORT OF THE MERCY MISSION

This course supports the mission of Mercyhurst University by creating students who are intellectually creative. Students will foster this creativity by: applying critical thinking and qualitative reasoning techniques to new disciplines; developing, analyzing, and synthesizing scientific ideas; and engaging in innovative problem solving strategies.

MATH 240 · SUGGESTED HOMEWORK · FALL 2019

Section	Exercises
§ 1.1: Background	1-12 (if non-linear, why?) 13,15
§ 1.2: Solutions & Initial Value Prob	2,3,6,7,8,9,11,17,18,22,23,25,27
§ 1.3: Direction Fields	1,3,5,10(a-c),11,15,17,19 (for 11-18, see our "Extras page" and use dfield)
§ 1.4: Euler's Method	1,5,7,11,15
§ 2.2: Separable Equations (I)	3,5,6,7,9,11,12,15,18,19,21,23
§ 2.2: Separable Equations (II)	13, 22,25
§ 2.3: Linear Equations (I)	1,3,4,5,7,11,17
§ 2.3: Linear Equations (II)	15,16,18,20,22,28, READ: 36
§ 2.4: Exact Equations (I)	1,2,7,9,11,12,13,16,22,23,25 FIX
§ 2.4: Exact Equations (II)	1,2,7,9,11,12,13,16,22,23,25
§ 2.6: Substitutions and Trans (I)	1,2,5,6,7,8,9,10,13 ($t > 0$), 18,23,25,27
§ 2.6: Substitutions and Trans (II)	Get caught up.
Chapter 2 Review	Chapter 1 & 2 Review Worksheet
§ 3.2: Mathematical Modeling	Handout Problems & continue Chapter 1 & 2 Review Worksheet; Get caught up
§ 3.2: Compartmental Analysis	1, 4,7,8 & § 2.3: 35
§ 3.4: Newtonian Mechanics	1,5,7 (you will need a calculator for these)
Exam 1	
§ 4.1: Introduction to Linear 2nd Order	2b, 5
§ 4.2: Second Order Linear Equations	1,5,13,15
§ 4.2: Second Order Linear Equations (I)	7,17,19,22, 39, (27,29 use any method to determine L.D.)
§ 4.2: Second Order Linear Eqns (II)	(28,31 use any method to determine L.D.), 37
§ 4.3: Auxiliary Eqns; Complex Roots (I)	1,3,9,11,17,21,22,24
§ 4.3: Auxiliary Eqns; Complex Roots (II)	26,29, 31(a-c), 32a, 33a
§ 4.4: Nonhomogeneous Equations (I)	1-8,13,14,15,16,18,27
§ 4.4: Nonhomogeneous Equations (II)	17,21,24, 29
§ 4.5: The Superposition Principle (I)	3,8,10,11,12,15
§ 4.5: The Superposition Principle (II)	17,21,24,25,27,33,35
§ 4.6: Variation of Parameters (I)	1,2,3,7,14
§ 4.6: Variation of Parameters (II)	11,15,17
§ 4.7: Variable-Coefficient Equations (I)	5-8, 11,13,19
§ 4.7: Variable-Coefficient Equations (II)	1,2, 24(a,b), 45,47, 37,39

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MATH 240 · SUGGESTED HOMEWORK · FALL 2019

Section	Exercises
§ 4.7: Variable-Coefficient Equations(III)	40,41,43,48
§ 4.9: A Closer Look at Free Vibrations	1,3,5,9,12,18
Chapter 4 Review Problems:	1,3,7,9,11,21,25,30,31,35,38
Exam 2	
§ 9.1: Systems Intro	1,3,5,7,11
§ 9.2: Linear Algebra Review	1,3,7,12
§ 9.3: Matrix Methods and Vectors	READ SECTION 9.3; work: 1,4,5,21,23,25 Note, we will not be finding inverses
§ 9.3: Matrix Methods and Vectors	27,33,34,35,37,39
§ 9.5: Eigenvalues/Eigenvectors	3,5,7,10
§ 9.4: Linear Systems in Normal Form (I)	1,3,5,7,9,11,21,24,26
§ 9.4: Linear Systems in Normal Form (II)	Get caught up
§ 9.5: Homogeneous Linear Systems (I)	11,13,15,31,32
§ 9.5: Homogeneous Linear Systems (II)	14 (Get caught up)
§ 9.6: Linear Sys Complex Eigenvals (I)	1,3,13,14
§ 9.6: Linear Sys Complex Eigenvals (II)	Handout (Get caught up)
Exam 3	
§ 5.4: Intro to the Phase Plane (I)	
§ 5.4: Intro to the Phase Plane (II)	
Qualitative Methods	Handout Problems
Final Exam	

MATH 240 · DIFFERENTIAL EQUATIONS TENTATIVE COURSE SCHEDULE · FALL 2019

Monday	Wednesday	Friday
	Aug 21 § 1.1: Background	Aug 23 § 1.2: Solutions & IVPs
Aug 26 § 1.3: Direction Fields	Aug 28 § 1.4: Euler's Method	Aug 30 § 2.2: Separable Equations (I)
Sep 2 No class: Labor Day	Sep 4 § 2.2: Separable Equations (II) § 2.3: Linear Equations (I)	Sep 6 § 2.3: Linear Equations (II)
Sep 9 § 2.4: Exact Equations (I)	Sep 11 § 2.4: Exact Equations (II)	Sep 13 § 2.6: Substitutions and Transformations (I)
Sep 16 § 2.6: Substitutions and Transformations (II)	Sep 18 Chapter 2 Review	Sep 20 §§ 3.1 - 3.2: Mathematical Modeling
Sep 23 § 3.2: Compartmental Analysis	Sep 25 § 3.4: Newtonian Mechanics	Sep 27 EXAM 1
Sep 30 §§ 4.1 - 4.2: Second Order Equations The Mass-Spring Oscillator	Oct 2 § 4.2: Second Order Equations Homogeneous Linear Equations (I)	Oct 4 § 4.2: Second Order Equations (II) § 4.3: Complex Roots (I)
Oct 7 § 4.3: Auxiliary Equations with Complex Roots (II)	Oct 9 § 4.4: Nonhomogeneous Equations (I)	Oct 11 No Class: Break
Oct 14 § 4.4: Nonhomogeneous Equations (II) § 4.5: Superposition Principle (I)	Oct 16 § 4.5: Superposition Principle and Undetermined Coefficients (II)	Oct 18 § 4.6: Variation of Parameters (I)
Oct 21 § 4.6: Variation of Parameters (II) § 4.7: Variable-Coefficient Equations (I)	Oct 23 § 4.7: Variable-Coefficient Equations (II)	Oct 25 § 4.7: Variable-Coefficient Equations (III)
Oct 28 § 4.9: A Closer Look at Free Mechanical Vibrations	Oct 30 § 4.9: Mechanical Vibrations Chapter 4 Review	Nov 1 EXAM 2
Nov 4 §§ 9.1 - 9.3: Review Matrix Methods and Vectors	Nov 6 § 9.3: Further Linear Algebra: eigenvalues & eigenvectors	Nov 8 § 9.3: Further Linear Algebra (II)
Nov 11 § 9.4: Linear Systems	Nov 13 § 9.5: Homogeneous Linear Systems Constant Coefficients (I)	Nov 15 § 9.5: Homogeneous Linear Systems Constant Coefficients (II)
Nov 18 § 9.6: Homogeneous Linear Systems Complex Eigenvalues (I)	Nov 20 § 9.6: Homogeneous Linear Systems Complex Eigenvalues (II)	Nov 22 § 5.4: Introduction to the Phase Plane (I)
Nov 25 EXAM 3	Nov 27 No Class: Thanksgiving	Nov 29 No Class: Thanksgiving
Dec 2 § 5.4: Introduction to the Phase Plane(II)	Dec 4 Notes: Qualitative Methods Visualizing Differential Equations BRING YOUR LAPTOP	Dec 6 Notes: Qualitative Methods Visualizing Differential Equations BRING YOUR LAPTOP
	Wednesday Dec 11	FINAL EXAM 1:00 - 3:00