On-Demand - Math 331: Differential Equations

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COURSE DESCRIPTION: MATH 331 is the concluding Calculus course designed for mathematics, science, and engineering majors. It delves into various advanced topics, including methods of solution for differential equations, the existence and nature of solutions, Laplace transform method, infinite series, numerical solutions, and practical applications.

Key Features:

- Access over 100 meticulously crafted recitation videos to enrich your learning experience.
- All videos are professionally recorded and edited by Dr. Ozer, ensuring clarity and coherence in presenting complex concepts.
- Detailed solutions for pivotal problems in Differential Equations are meticulously elucidated within the videos, empowering you to engage with the material at your own pace and convenience.

MEETING TIMES

Given the online nature of this course, there are no physical meetings to attend. Furthermore, since it is self-paced, you can complete the course in as little as seven weeks or extend your studies over nine to twelve months. For precise information regarding the course completion deadline, please get in touch with WKU On Demand.

MAIN LEARNING OBJECTIVES

1. **Conceptual Understanding:** Develop a deep understanding of the theoretical concepts underlying differential equations, including the distinction between linear and nonlinear equations, families of solutions, and criteria for the existence and uniqueness of solutions.
2. **Problem-solving Skills:** Develop expertise in solving various differential equations, encompassing first-order, second-order, and higher-order equations, employing traditional pen-and-paper methods and modern computational tools. This entails deriving general solutions, applying initial and boundary conditions, and interpreting the results.
3. **Method Selection and Application**: Learn to select and apply appropriate solution methods for different differential equations, such as undetermined coefficients, variation of parameters, substitutions, power series, and Laplace transforms. Understand when and how to use these methods effectively to solve specific problems.
4. **Modeling and Interpretation:** Develop the ability to model real-world phenomena using differential equations, particularly linear models for physical systems. Gain insight into interpreting solutions and understanding their implications in practical contexts.

5. **Numerical Methods and Accuracy Assessment**: Familiarize yourself with numerical methods for approximating solutions to differential equations, such as Euler's method. Learn how to assess the accuracy of numerical approximations and compare them with exact solutions, enhancing your problem-solving skills in theoretical and practical settings.

Check the end of the syllabus to learn about specific learning objectives for each chapter.

PREREQUISITES: MATH 137 with a minimum grade of C.

REQUIRED MATERIALS

Textbook: Differential Equations with Boundary-Value Problems, 10th Edition, by Dennis G. Zill (Also available online at www.webassign.net)

WebAssign access code is required for tests, quizzes, and homework assignments.
Course ID is not needed. Register through Blackboard.

Calculator: A graphing calculator (TI-83 Plus or TI-84 Plus or Silver Edition), except the TI-92 or TI-89 or equivalent, is recommended for the assignments and Testing Center exams.

Textbook Information: (Please read before purchasing anything for this course.)
This course participates in The WKU Store's Day One Access program. This program is designed to provide immediate access to required materials for all students at prices cheaper than any other option.

Required materials will be available to you automatically (via Blackboard) when you enroll in this course unless you choose to opt out. By participating in this program, The WKU Store will bill your Student Billing account, and you will see a charge appear under this Term along with Tuition and Fees ("Account Summary by Term" under the Student Services tab) labeled as either "The WKU Store Purchases" or "Day One Access." For more information on this program or to opt out of participation, please visit the Day One Access information page.

The cost of the e-book and WebAssign is approximately $80, which will be charged to your student bill one week after your course enrollment. Students who stay enrolled in Day One Access are also eligible to purchase an optional low-cost loose-leaf copy of the textbook for only $45.00. (Students who opt-out of Day One Access are not eligible to purchase this low-cost loose-leaf version of the book.)

Students who wish to opt-out of this program may do so. However, you must opt-out within the first week of your enrollment to avoid being charged for Day One Access. By opting out, you agree to have your e-book and Webassign access terminated and you will be responsible to obtaining the required materials on your own. If you have purchased the optional low-cost loose-leaf book from The WKU Store, you must return it before the opt-out deadline in order complete the opt-out process. It must also be in its original shrink-wrap.

**********Contact WebAssign directly if you have a technical issue with the website. The phone number is (800) 955 8275********

COURSE WEBSITE AND REQUIRED TECHNOLOGIES: We will be using WKU's Blackboard as the homepage and Cengage's WebAssign for assignments and accessing the e-book for this course. Lecture notes/videos, recitation notes/videos, surveys, and announcements are all uploaded to the

corresponding course modules in Blackboard. Please note that all course announcements posted in Blackboard will be sent to your WKU EMAIL address. All assignments will be completed in the WebAssign Platform. Access WebAssign via the link provided on the Blackboard homepage. Additionally, course videos are linked to my YouTube Channel.

- **Broadband Reliable Internet Connection:** A reliable internet connection is crucial for accessing course materials and completing assignments. Ensure your internet connection meets the requirements outlined herehttps://www.webassign.net/manual/student_guide/common/system-requirements.htm

- **Smart Phone & Zoom Software:** A microphone and webcam may be required during online quizzes or exams. Make sure your smartphone's camera and microphone are enabled during Zoom proctoring. Note that this may not be necessary for Testing Center exams.

- **WebAssign Technology Requirements:** Familiarize yourself with the technology requirements specific to WebAssign. Visit the WebAssign website for more details: WebAssign System Requirements.

- **LockDown Browser of WebAssign**: Install LockDown Browser of WebAssign for online exams (if required due to COVID-19). When using LockDown Browser, you cannot access other applications or websites, copy or print, and some WebAssign features may also be unavailable.

- **About Uploading Your Hand-written Work for Online Assignments:** Prepare your hand-written work in the required format (PNG, JPEG, or PDF) and upload it as instructed. Ensure your file is not larger than 10 MB. Full credit may be automatically awarded upon submission, with adjustments made after grading by your instructor. For more information, refer to the guidelines for uploading files: Uploading a File to Show Your Work.

RECITATIONS VIDEOS

Recitations for this course are provided through recorded videos. A PowerPoint file contains links to recitation questions and videos within each course submodule. These videos, presented by Dr. Ozz, cover solved exercises similar to those in the assignments. Each section typically includes 2-8 videos. To maximize your learning experience, we recommend following these steps:

- Read the lecture notes to familiarize yourself with the concepts.
- Engage with the recitation videos to see solved examples and reinforce your understanding.
- < UNK> Incorporating recitation videos into your study routine can deepen your comprehension and improve your problem-solving skills.

HOMEWORK and CHAPTER REVIEWS (15%)

There will be 30 homework assignments and 6 chapter reviews, all to be completed using the online assessment system, WebAssign. It is imperative to stay current with these assignments to maintain progress in the course. Each assignment will have varying question types, with one attempt allowed for multiple-choice questions and up to ten attempts for all other questions. To proceed to the next assignment, a minimum grade of 70% is required on each assignment. Technical difficulties are not considered valid excuses for missed homework. Each homework assignment may include 0-2 questions requiring hand-

written work for instructor feedback. Photograph your hand-written solutions and upload the file to WebAssign. Feedback will typically be provided within 1-3 days after submission.
To accommodate unforeseen circumstances, your **five lowest homework scores will be dropped** at the end of the course.

When you have completed each homework assignment, please email the instructor to prompt him to provide constructive feedback on your hand-written solution(s).

QUIZZES (35%)

Throughout the course, 15 quizzes will be administered via the online assessment platform WebAssign. Each quiz will encompass material from the preceding two sections of the course.
You will have 60 minutes to complete each quiz, with one attempt permitted for multiple-choice questions and up to three attempts for all other questions. Additionally, each quiz will include two questions requiring hand-written work for instructor grading. You must provide all the work for these questions by photographing your hand-written solutions and uploading the file to WebAssign. WebAssign grading will not be considered for these questions, and feedback will be provided within 1-3 days after submission. To accommodate potential challenges or unforeseen circumstances, the **four lowest quiz scores will be dropped** at the end of the semester. This ensures that your final grade reflects your overall performance accurately.

Please email the instructor when you have completed each quiz to notify him grade the written portion of the quiz.

TESTS (20+15%) and FINAL EXAM (15%)

This course will have two 120-minute tests and a final exam. Test 2 is taken online with the LockDown. You must provide all the details of your solutions. Test 1 and the Final Exam are taken at a testing center. You may bring your formula card for test 1 and the final exam. You will be allowed ONE attempt for multiple-choice questions and TWO for all other questions. Only non-graphing TI-83/84 calculators (except the TI-92 or TI-89 or equivalent) are permitted during exams, and formula sheet(s) will be provided. For the testing center exams, you can bring your formula card. The formula card must be sized 4x6" for the first test and 8x11" for the final exam, with both sides of the card available for use.

Test 1 and the Final Exam must be taken at a testing center, at either WKU or a certified proctoring location near you. Please remember that there may be an associated proctoring fee at non-WKU testing centers. For more information on scheduling proctored exams, please visit On Demand's website.

Please email the instructor before you start scheduling your test.

GRADING and GRADING SCHEME: The course contains 30 homework assignments, 4 chapter review assignments, 15 quizzes, 2 tests, and 1 final exam. All assignments are worth 100 points. Your final grade is based on the following grading scheme:

Homework (online)	Quizzes (Online)	Test 1	Test 2 (Online)	Final Exam	**Total**

15%	35%	20%	15%	15%	**100%**

Grading Scheme				
A	B	C	D	F
≥ 90%	80-88%	70-79%	60-69%	≤59%

COMMUNICATION BY THE INSTRUCTOR

For any inquiries or concerns, please feel free to reach out to me via email. My email address is provided at the beginning of the syllabus. I try to check my email regularly throughout the school year, typically daily, and at least every few days during breaks. However, if I am traveling out of the country or the state, my access to the internet may vary, affecting the frequency of my email checks.

Please note that responses to emails sent over the weekend may take longer than those sent during weekdays. We can arrange a meeting via phone, Zoom, Google Phone, or face-to-face to address any urgent matters or questions. Your communication is important to me, and I am committed to providing timely assistance and support.

NETIQUETTE: Netiquette refers to the guidelines for online communications. In a nutshell, it is the etiquette for the Internet and should be used for all class communication for the course: email, discussion forums, messages, etc. Even though this is an online course, students are expected to conduct themselves in a manner that is respectful and upholds a supportive, mutually beneficial learning environment.

Netiquette provides excellent online behavior guidelines that facilitate the productive and thoughtful exchange of ideas. Some of the basic tenets of Netiquette include:

- **Be respectful.** Remember that you are communicating with actual people. Always be courteous and show respect, especially when there are differences of opinion, beliefs, or cultural backgrounds.
- **Think before you post.** Be aware of who may be able to view your posting and how your post may be interpreted. Try to maintain a fair and objective tone.
- **Write clearly.** Even though the online environment may seem more informal than your face-to-face class, this is still an academic course, and mature communication is expected. Correct spelling and grammar are required, and proper composition and punctuation are expected.
- **Use appropriate language and style.** Profanity or offensive wording will not be tolerated. You should avoid using ALL CAPS and repeated punctuation (???? or !!!!).
- **Be considerate of others.** Do not make derogatory, condescending, or harassing remarks. Communication should be well-intentioned, well-articulated, and aimed at fostering a positive learning environment. Be aware of how your readers may misinterpret sarcasm.
- **Allow for misunderstandings.** Remember that writing often conveys the incorrect tone or intention in the absence of nonverbal communication. It would be best if you made allowances. What you may perceive as rudeness may be unintended.
- **Cite your sources.** If you post work that is not your own, reference your sources.

ACADEMIC DISHONESTY: Students who commit any act of academic dishonesty may receive from the instructor a failing grade in that portion of the coursework in which the act is detected or a failing grade in the course without the possibility of withdrawal. The faculty member may also present the case to the Office of Judicial Affairs for disciplinary sanctions.

STUDENT RESOURCES PORTAL

There is a student resource portal (http://www.wku.edu/online/srp/) that you can access to help you succeed in the course.

TITLE IX MISCONDUCT/ASSAULT STATEMENT

Western Kentucky University (WKU) is committed to supporting faculty, staff, and students by upholding WKU's Title IX Sexual Misconduct/Assault Policy (#0.2070) at https://www.wku.edu/policies/docs/182.pdf and Discrimination and Harassment Policy (#0.2040) at https://www.wku.edu/policies/docs/251.pdf.

Under these policies, discrimination, harassment, and/or sexual misconduct based on sex/gender are prohibited. If you experience an incident of sex/gender-based discrimination, harassment and/or sexual misconduct, you are encouraged to report it to the Title IX Coordinator, Andrea Anderson, 270-745-5398 or Title IX Investigators, Michael Crowe, 270-745-5429 or Joshua Hayes, 270-745-5121.

Please note that while you may report an incident of sex/gender-based discrimination, harassment, and/or sexual misconduct to a faculty member, WKU faculty are "Responsible Employees" of the University and MUST report what you share to WKU's Title IX Coordinator or Title IX Investigator. If you would like to speak with someone who may be able to afford you confidentiality, you may contact WKU's Counseling and Testing Center at 270-745-3159.

REGULAR AND SUBSTANTIVE INTERACTION STATEMENT: The U.S. Department of Education requires that distance education courses must include regular and substantive interaction between students and faculty. For more information about Regular and Substantive Interaction (RSI) at WKU, please visit the Regular and Substantive Interaction in Online and Distance Learning webpage.

In this course, regular and substantive interaction will take place in the following ways:

- Regular virtual office hours
- Timely and detailed feedback on student's coursework provided within 1-3 days after the submission of an assignment
- Providing information or responding to questions about the content of the course or course competency

ADA STATEMENT: In compliance with the University policy, students with disabilities who require academic and/or auxiliary accommodations for this course must contact the Student Accessibility Resource Center located in Downing Student Union, 1074. SARC can be reached by phone number at 270-745-5004 [270-745-3030 TTY] or via email at sarc.connect@wku.edu. Please do not request accommodations directly from the professor or instructor without a faculty notification letter (FNL) from The Student Accessibility Resource Center.

This course uses third party websites and tools that are committed to providing an accessible experience to their users. You can read the individual accessibility statements for these platforms by clicking the links below:

- WKU's Accessibility Statement
- Blackboard's Accessibility Statement
- WebAssign's Accessibility Statement
- YouTube's Accessibility Statement
- Zoom's Accessibility Statement

DETAILED CHAPTER OBJECTIVES

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

Chapter 1 (1.1-1.2): Introduction to Differential Equations

1. Understand the differential form of a first-order ordinary differential equation (ODE) and its representation in normal form.
2. Differentiate between linear and nonlinear ODEs, recognizing their distinct properties and solution methods.
3. Distinguish between functions and solutions in the context of solving differential equations.
4. Explore families of solutions and particular solutions to ODEs, including piecewise-defined and singular solutions.
5. Understand the concept of the interval of definition for a solution and its implications for the existence and uniqueness of solutions.
6. Learn criteria for establishing the existence and uniqueness of solutions to initial value problems for ODEs.
7. Determine the interval over which a unique solution exists for an initial value problem.

Chapter 2 (2.1-2.6). First-order Differential Equations

1. Understand solution curves, direction fields, and qualitative analysis for first-order differential equations, interpreting slopes and behaviors near specific points and as independent variables approach infinity.
2. Recognize the importance of continuity conditions in determining the existence and uniqueness of solutions to differential equations.
3. Develop problem-solving skills by applying techniques such as separation of variables, integration, and substitution to solve various types of first-order differential equations, including separable, linear, exact, and nonexact equations.
4. Gain proficiency in finding integrating factors for linear first-order differential equations, understanding their role in transforming nonexact equations into exact ones.
5. Learn methods for transforming nonexact differential equations into exact ones using integrating factors and identify homogeneous equations and Bernoulli's equation for substitution methods.
6. Gain proficiency in solving exact differential equations using integrating factors and applying substitution methods, such as reduction to separation of variables.
7. Understand the basics of numerical methods for approximating solutions to differential equations, including Euler's method.
8. Learn how to assess the accuracy of numerical approximations by comparing approximate and actual values and calculating relative error measures.

Chapter 3 (3.1). Modeling with Linear First-order Differential Equations

1. Understand applying linear first-order models to real-world phenomena such as growth, decay, fluid mixing, and series circuits.
2. Develop proficiency in formulating and solving linear first-order differential equations to model these phenomena.
3. Gain insight into interpreting solutions to linear first-order models and their implications for understanding real-world processes.

Chapter 4 (4.1-4-10). Higher-order Differential Equations

1. Understand the theory of linear equations, including initial-value and boundary-value problems, and differentiate between homogeneous and nonhomogeneous equations.
2. Gain proficiency in reducing the order of linear differential equations and applying reduction of order techniques to solve differential equations.
3. Develop a deep understanding of homogeneous linear equations with constant coefficients, including solving them using the auxiliary equation method.
4. Learn to solve nonhomogeneous linear equations using the method of undetermined coefficients, including the superposition and annihilator approaches.
5. Understand the concept of variation of parameters and its application in solving linear differential equations, revisiting linear first-order differential equations in the process.
6. Gain proficiency in solving Cauchy-Euler equations and understand their significance in differential equations.
7. Learn about Green's functions and their applications in solving initial-value and boundary-value problems for linear differential equations.
8. Develop skills in solving systems of linear differential equations by elimination and understand systematic elimination techniques.
9. Gain insight into the characteristics and differences of nonlinear differential equations compared to linear equations.

Chapter 5 (5.1,5.2). Modeling with Higher-order Differential Equations

1. Understand the application of higher-order differential equations in modeling physical systems, focusing on linear models for initial-value problems.
2. Gain insight into the behavior of spring/mass systems, including free undamped motion, free damped motion, and driven motion, and their mathematical representation using differential equations.
3. Learn about the analogies between spring/mass systems and electrical circuits, including the series circuit analog, and their significance in modeling physical phenomena.
4. Develop proficiency in solving initial-value problems for linear models using higher-order differential equations.
5. Explore boundary-value problems and their applications in modeling physical systems, such as the deflection of a beam.
6. Understand the mathematical techniques in solving boundary-value problems for linear models, including determining the beam's deflection.

Chapter 6 (6.1-6.3) Series Solutions of Linear Equations

- Understand the significance of linear differential equations with variable coefficients in real-world applications compared to those with constant coefficients.
- Recognize the limitations of finding nontrivial elementary function solutions for linear high-order equations with variable coefficients, particularly near singular points.
- Learn methods for finding linearly independent solutions of linear second-order differential equations with variable coefficients, particularly around ordinary and singular points.
- Gain proficiency in analyzing and solving linear differential equations with variable coefficients using power series methods, focusing on their behavior near ordinary and singular points.
- Develop an understanding of how solutions of linear differential equations with variable coefficients are represented by infinite series and their implications for real-world applications, particularly near ordinary and singular points.

Chapter 7 (7.1-7.6) The Laplace Transform

1. Understand the definition of the Laplace Transform and its application as an integral transform in solving differential equations.
2. Develop proficiency in computing inverse Laplace transforms and Laplace transforms of derivatives and their applications in solving differential equations.
3. Learn about the operational properties of the Laplace Transform, including translation on the s-axis and translation on the t-axis, and their implications in solving differential equations.
4. Gain insight into advanced operational properties of the Laplace Transform, such as derivatives of a transform, transforms of integrals, and transforms of periodic functions and their applications.
5. Understand the concept of the Dirac Delta function and its role as a unit impulse in modeling dynamic systems, particularly in solving differential equations.
6. Develop skills in solving systems of linear differential equations using the Laplace Transform, with a focus on coupled spring systems and their mathematical representations.