Math 230 – Differential Equations
Spring 2019 Course Syllabus

James Jones, Professor of Mathematics
Mathematics, Science, and Business Division – Richland Community College

Course Meeting Information

Section 01 meets from 12:30 to 1:40 pm on Monday, Wednesday, and Friday in room S137. The class meets from January 14th to May 10th.

The comprehensive final exam will be Friday, May 10th, from 12:00 to 1:50 pm.

This is a face-to-face course, but the Canvas learning management system will be used. There is an online student orientation to Canvas and the College that must be completed prior to obtaining access to your courses in Canvas.

Submitting assignments in Canvas does not count as attending class.

Instructor Information

James Jones, Professor of Mathematics   Phone: 217-875-7211, ext 6490
Email: james@richland.edu   Office: S224
Web: https://people.richland.edu/james   Canvas: https://richland.instructure.com

The best way to contact the instructor is through Canvas or by email. Please do not leave a voice mail as it will not reach the instructor in time to help you.

Office Hours

I spend most of my office hours in the classroom, room S137. This allows me to help students with their assignments, homework, projects, exams, and questions. Students are encouraged to come to class early each day and use that time to ask questions of the instructor, work on projects, or just socialize with other students in the course.

- Monday: 8:45-9:00 am, 10:10-10:30 am, 1:40-2:00 pm, 3:10-3:30 pm, 4:40-4:55 pm
- Wednesday: 8:45-9:00 am, 10:10-10:30 am, 1:40-2:00 pm, 3:10-3:30 pm, 4:40-4:55 pm
- Friday: 8:45-9:00 am, 10:10-10:30 am, 1:40-2:00 pm, 3:10-3:30 pm

Text

- Differential Equations with Boundary-Value Problems, seventh edition. Dennis G. Zill, Michael R Cullen. Copyright 2009, Brooks/Cole. ISBN-13: 978-0-495-10836-8 (required)

- Differential Equations with Boundary-Value Problems Student Solutions Manual. Warren S. Wright, Dennis G. Zill, Carol D. Wright. Copyright 2009, Brooks/Cole Publishing Company. ISBN 978-0-495-38316-1. (Optional)

Student Audience

Transfer students. Students pursuing degrees in engineering or mathematics.

Prerequisite

Successful completion (C or better grade) of Math 122, Calculus and Analytic Geometry II.

Course Description

MATH 230 - Differential Equations
Hours: 4 lecture - 0 lab - 4 credit

Math 230, Differential Equations, begins with some definitions and terminology and mathematical models used in a differential equations course. First-order and higher-order differential equations, along with the methods of solutions and their applications are introduced. Modeling with higher-order, Laplace transform, and systems of linear first-order differential equations are covered. At the end, students learn series solutions of linear equations. Numerical methods are covered throughout the course.

Applicable toward graduation where program structure permits.

- Certificate or degree: All certificates and all degrees.
- Group requirement: Mathematics
- Area of Concentration: Mathematics.

Illinois Articulation Initiative (IAI)

The Illinois Articulation Initiative is a statewide transfer agreement. Their website is at http://www.itransfer.org

Differential Equations is the Mathematics Majors course MTH 912. This is the IAI description for the course.

The course must cover: First-order equations (including initial value problems, basic numerical methods, existence and uniqueness of solutions, separable equations, linear equations, exact equations, substitution methods and applications). Higher-order equations (including the general solution to homogeneous linear equations, linear independence, method of undetermined coefficients, the general solution to linear non-homogeneous equations, variation of parameters, and applications). In addition to the above, the course must cover at least two of the following in detail: 1. Solutions of initial value problems by Laplace transforms, 2. Power series solutions, 3. Partial differential equations and Fourier series, 4. Systems of linear differential equations, 5.

Further numerical methods, 6. Non-cursory treatment of other advanced topics.
Prerequisite: MTH 902, Calculus II with a C or better.

Topical Outline

A weekly calendar listing the specific material covered each week is provided at the end of this syllabus. This section is provided as a broad overview of the major topics covered.

This course does not run on calendar weeks and any attempt to coerce the calendar into a weekly schedule necessarily introduces some approximation. For example, an exam may be in a different week than the weekly heading suggests or a chapter may begin midweek.

The official calendar that the students receive is a one page, 16 week, daily calendar. This calendar lists the section from the textbook being covered each day and the dates that major assessments are due. Due dates will also be listed in the Canvas learning management system.

- Introduction to Differential Equations – 1 week
- First-Order Differential Equations – 3 weeks
- Second-Order Differential Equations – 4 weeks
- Series Solutions – 2 weeks
- Laplace Transforms – 3 weeks
- Systems of Differential Equations – 3 weeks

Models and Applications

For first- and second-order differential equations, the textbook breaks application problems and mathematical models into separate chapters after covering the theory. This course combines the applications and the theory. Since applications may be worked using multiple methods, it becomes too lengthy to list the applications on the calendar. Rather, some of the major models that we will cover are listed here.

First-Order Models

- Linear models; exponential growth and decay, Newton's law of cooling, mixture problems, series circuits
- Non-linear models; logistic growth, chemical reactions

Higher-Order Linear Models

- Initial value problems; spring/mass systems with free undamped motion, free damped motion, and driven motion; series circuit analogue
- Boundary value problems; deflection of a beam, eigenvalues and eigenfunctions, buckling of a column

Systems of Differential Equations

- First-order: Mixture problems involving systems of tanks, electronic networks
- Second-order: Coupled springs, electronic networks

General Course Objectives

While learning differential equations is certainly one of the goals of this course, it is not the only objective. Upon completion of this course, the student should be able to ...

- demonstrate comprehension and understanding in the topics of the course through symbolic, numeric, and graphic methods.[1]
- demonstrate the use of proper mathematical notation.[1]
- use technology when appropriate and know the limitations of technology.[4]
- work with others towards the completion of a common goal.[2,4]
- use deductive reasoning and critical thinking to solve problems.[4]
- apply common sense to mathematical problems.[4]
- effectively communicate the student's understanding of the subject.[1,2]

The numbered superscripts refer to the Richland Cross-Disciplinary Outcomes addressed by that objective.

Richland Cross-Disciplinary Outcomes

Richland Community College has established some outcomes for degree-seeking students. These are not necessarily completed within a single course, but should be demonstrated and assessed at some point before the student graduates. Richland may utilize anonymous student work samples for outcomes assessment and continuous improvement of courses and programs.

The degree-seeking student at Richland Community College will:

1. communicate effectively in writing.
2. communicate effectively orally.
3. access, evaluate, and appropriately use information in research and applied contexts.
4. think critically and creatively.

Type of Instruction

Discussion, problem solving, student questions, student participation, oral presentations, and lecture. Students are expected to read the material before coming to class and are strongly encouraged to come to class with a list of questions and to ask these questions.

Method of Evaluation

Any of the following methods of evaluation may be used: problem solving exams, objective exams, essays, research papers, oral presentations, group projects, individual projects, quizzes, homework, and a learning portfolio.

65% of the course grade will be assigned through proctored assessments. There is no extra credit.

In-Class Exams (65% – proctored)

There will be three chapter exams plus a comprehensive final.

- **Exam 1**: First Order Differential Equations (15%)
- **Exam 2**: Higher Order Differential Equations (15%)
- **Exam 3**: Laplace Transforms (15%)
- **Final Exam**: Comprehensive final exam (20%)

Take-Home Exams (20%)

Some of the material in Differential Equations is too time consuming to adequately test in a 70 minute period; this content will be assessed with take-home exams.

- **Take Home 1**: Applications of First Order Differential Equations (5%)
- **Take Home 2**: Applications of Second Order Differential Equations (5%)
- **Take Home 3**: Series Solutions (5%)
- **Take Home 4**: Systems of Differential Equations (5%)

Assignments (15%)

This is a catch-call category for all other assignments, assessments, and activities in the course. 10% of the assignments in this category will be dropped.

- **Homework** problems from the textbook will be assigned. These are mostly-odd problems from the book that students work and check using answers from the back of the book, the class wiki, intuition, other students, or the instructor. Homework is essential to mastering the material. Problems on the exams are often similar to problems from the homework. Instead of turning in homework, students will be given a quiz in Canvas with a few short questions similar to the problems they worked for the homework.
- **Technology Projects** will involve writing computer programs or using a computer algebra system to solve the more challenging problems.
- **Quizzes** will be given, especially to assess learning during long chapters.
- **Chapter Highlights** are summary documents of the important concepts in a chapter that are prepared by the student to help them review and understand each chapter.

Grading Policy

Letter grades will be assigned to final adjusted scores as follows:

A: 90-100%   B: 80 - 89%   C: 70-79%   D: 60-69%   F: below 60%

Final scores will be rounded to the nearest integer, so a 79.5% will round up to 80% and be considered a "B".

All grades are subject to audit and correction. Sometimes mistakes are made entering grades, other times mistakes are made in the grading itself. Your grade may increase or decrease when this happens. For this reason, you should strive to do better than the minimum needed for the grade you desire.

Consideration may be given to such qualities as participation, attitude, and cooperation to produce the optimal learning situation for everyone.

Grades will be kept inside the Canvas learning management system.

Unless indicated otherwise, assignments that are turned in on paper are due in class, even though the due date in Canvas may indicate the end of the day. The instructor may allow you to turn them in later that day without counting them late, but do not count on his graciousness. Late assignments lose 20% of their value per class period. The instructor reserves the right to apply this rule to missed exams as well as regular assignments. No late work will be accepted after the final.

Attendance Policy

Participation vs Attendance

This class expects that you participate, not just that you attend. Participation involves attendance, being familiar with the material, taking notes, reading the book, attempting homework, submitting projects, and participating in discussions.

Attending class without engaging while there does not qualify as participation. Submitting assignments without attending class does not qualify as participation, either. Both are required for participation.

Regular attendance and participation is essential for satisfactory completion of this course. You need to be actively involved in this course several times a week, if not daily. You need to regularly monitor your Canvas inbox and Richland email for notifications and information.

Students who do not communicate with the instructor and have irregular or infrequent attendance, miss the first day of class, or miss any two consecutive days may be dropped.

Students who, because of excessive absences, cannot complete the course successfully, are required to be administratively dropped from the class at midterm. If a student stops attending after midterm, it is the student's responsibility to withdraw to avoid an "F". Do not stop participating and assume that you will be withdrawn from the class by the instructor.

Although dropping students for non-attendance at midterm is required, students whose participation in the course is occasional or sporadic may be dropped from the class at any point during the semester at the instructor's discretion. The safest way to make sure you're not dropped for non-attendance is to continue to actively participate in the course.

The student is responsible for all assignments, changes in assignments, or other information given in the course. Regularly and frequently monitor your communications for updates or changes, but communicate with your classmates to get notes and other information.

Time Requirements

In 34 CFR 600.2, the federal government requires that the amount of student work for a credit hour reasonably approximates not less than one hour of class and two hours of out-of-class work per week for each semester hour and that a 50 minute period is acceptable for class or lecture.

Richland considers the minimal meeting time as 50 minutes per week for 15 weeks for each credit hour. Since this course is a four credit hour course, that means 50×15×4 = 3,000 minutes of class time. That is 3000÷60=50 hours of class time.

There is to be a reasonable approximation of two hours of outside time for each hour inside class, so the 50 hours of classroom instruction needs 100 hours of outside work. In total, you should expect to spend a minimum of 150 hours this semester for this course.

Since the course meets for 15 weeks, that is an average of 150÷15=10 hours per week. Note that the 150 hours is a minimum, but that the 10 hours per week is an average.

> You should expect to spend a minimum of 10 hours per week on this course.

If you are taking 16 credit hours, then you should expect to spend at least 40 hours a week on course work. That is the equivalent of a full-time job. The government considers that if you are taking 16 credit hours, that being a student is your full-time job.

According to the federal regulations, this target is a minimum, not an average.

Failure of the course to meet these time requirements could result in loss of program integrity, forcing the college to recover federal financial aid, and ultimately loss of accreditation.

At face value, it sounds overwhelming and impossible, but the time outside the class includes reading the book, watching videos, working on homework and projects, and participating in discussions.

The point is to manage your time effectively so that you don't feel the course is overwhelming.

Technology

The use of technology in this course is consistent with the Technology Statement in the Illinois Mathematics & Computer Science Articulation Guide (IMACC, 2016, p. 4). Technology is used to enhance the learning of Differential Equations, but it is not the focus of the instruction. There will be instances when we will use the calculator or computer to aid in our understanding or remove some of the tediousness of the calculations (especially in the area of numerical approximations). There may be some projects, homework, or portions of a test that require you to use technology to complete.

Here are some of the technology tools that we may use.

Calculator

This class is an upper-level mathematics class and a graphing calculator is preferred. That said, differential equations does not use many of the typical features of a graphing calculator (graphing functions, finding values from the graph, displaying a table of values, and finding the definite integrals numerically), so a scientific calculator may be sufficient. A Texas Instruments TI-84 or TI 83 is the recommended calculator and will be used by the instructor for demonstration purposes.

The TI-89 or TI-Nspire CAS calculators have a computer algebra system (CAS) built in and offer advantages, especially if you plan on taking additional calculus or engineering courses. A word of caution: having an advanced calculator does not compensate for having weak calculus skills.

Calculators may be used to do homework and may be used on exams and/or quizzes in class unless otherwise announced.

Maxima

Maxima is an open-source computer algebra system that is free for you to download and use at home. It is available from http://maxima.sourceforge.net/

WinPlot

WinPlot is a free graphing software package for Windows written by the late Rick Parris at Phillips Exeter Academy in Exeter, New Hampshire. The software is useful for creating graphs and it is easy to copy/paste the graphs into other applications. Exeter Academy maintained the server with the software for about 4 years after Parris' death, but the site is no longer available.

To download the software, visit the instructor's Mathematical Software page at
https://people.richland.edu/james/software

Microsoft Excel

This spreadsheet application is useful for numerical methods such as Euler, Improved Euler, and Runge-Kutta 4. It is loaded on all of the student computers at Richland.

Microsoft Office 365, which includes Word, Excel, PowerPoint, Access, and Publisher, is available free to students enrolled in credit courses at Richland through the Microsoft Student Advantage program. More information is available at
https://jics.richland.edu/MicrosoftStudentAdvantage/

Additional Supplies

The student should bring a pencil, paper, and calculator to class each day. You may occasionally want a ruler or graph paper. There will be a paper punch and stapler in the classroom.

Additional Help

The student is encouraged to seek additional help when the material is not comprehended. Mathematics is a cumulative subject; therefore, getting behind is a very difficult situation for the student. There are several places where you can seek additional help in your classes.

You may use a recording device to record the lectures. Feel free to use a camera or cell phone to take pictures of the boards if you have trouble getting all of the information into your notes.

Instructor

I try to make myself as available to the students as I can. My office hours are listed at the beginning of this syllabus, but those are just the times I'm scheduled to be in my office. Grab me and ask me questions if you see me in the hallway. Ask questions before or after class. If I'm in my office and it's not my scheduled office hours, go ahead and stop in.

The instructor should be considered the authoritative source for material related to this class. If a tutor or other student says something that disagrees with the instructor, believe the instructor.

Study Groups

Probably the best thing you can do for outside help is to form a study group with other students in your class. Work with those students and hold them accountable. You will understand things much better if you explain it to someone else and study groups will also keep you focused, involved, and current in the course.

Mathematics Enrichment Center

The Mathematics Enrichment Center, located in S118, provides free walk-in tutoring for mathematics courses.

Academic Success Center

The Academic Success Center consolidates several student services into one area. It is located in the south wing of the first floor next to the Kitty Lindsay Learning Resources Center (library).

Testing

The testing center is located in room N114. You must provide a photo identification and know the name of your instructor to use this service.

Tutoring

The tutoring center provides tutoring on a walk-in or appointment basis in room C148. Students seeking mathematics tutoring should visit the Mathematics Enrichment Center.

Accommodations

There are accommodations available for students who need extended time on tests, note takers, readers, adaptive computer equipment, braille, enlarged print, accessible seating, sign language interpreters, books on tape, taped classroom lectures, writers, or tutoring. If you need one of these services, then you should see Learning Accommodation Services in room C148. If you request an accommodation, you will be required to provide documentation that you need that accommodation.

Online Learning

Despite the title, Online Learning provides help with much more than just your online courses. They provide technical support for students including answering questions about Canvas, myRichland, e-mail, cell phones, tablets, and laptops. They can also help troubleshoot your computer issues and make sure your computer is ready for course work.

They are located in room W143, but the best way to contact them is through the "Help" link in the lower-left corner of Canvas or at http://www.richland.edu/online/helpdesk.

Open Computer Labs

Students often wish to know where, besides the classroom, they can go to use the software. There are computers located in the Learning Resources Center and in the Academic Success Center that you may use.

Richland Thrive

Richland Thrive is an implementation of an early-alert identification and intervention system powered by the Hobsons' Starfish software. The software is designed to help students achieve academic success, retention, and graduation.

When academic indicators suggest a student may be experiencing difficulties that may negatively impact academic success, the instructor may raise a referral flag that notifies the student of concern through an email to the student's Richland (Zimbra) email, requests a Student Success Coach or Student Success staff member contact the student to discuss and follow-up on the issue, or encourages student to discuss the matter with the instructor.

If you receive an email notification of a referral flag in any of your courses, you are encouraged to contact the instructor as soon as possible to discuss the issue. The purpose of the discussion is to accurately assess its potential impact on your academic success and to plan and put into action steps to be successful in the course. For more information about the Richland Thrive system, contact the Student Success Center at ext. 6267

College & Division Policies

Academic Dishonesty Policy

Each student is expected to be honest in his/her class work or in the submission of information to the College. Richland regards dishonesty in classroom and laboratories, on assignments and examinations, and the submission of false and misleading information to the College as a serious offense.

A student who cheats, plagiarizes, or furnishes false, misleading information to the College is subject to disciplinary action up to and including failure of a class or suspension/expulsion from the College.

Non-Discrimination Policy

Richland Community College policy prohibits discrimination on the basis of race, color, religion, sex, marital or parental status, national origin or ancestry, age, mental or physical disability (except where it is a bonafide occupational qualification), sexual orientation, military status, status as a disabled or Vietnam-era veteran.

Electronic Communication Devices Policy

The Mathematics and Sciences Division prohibits the use of cell phones, pagers, and other non-learning electronic communication equipment within the classroom. All equipment must be turned off to avoid disturbances to the learning environment. If a student uses these devices during an examination, quiz, or any graded activity, the instructor reserves the right to issue no credit for these assignments. The instructor needs to approve any exceptions to this policy.

Other College Services

There are some additional services that Richland provides to its students. While they may not directly pertain to this class, you may benefit from them.

Learning Feedback System

At the end of each semester, students are invited to provide feedback to their instructors about the course. This includes things that went well and opportunities for improvement. This online feedback is anonymous and the instructor won't see it until grades have been turned in.

The Learning Feedback System (LFS) is primarily intended to provide feedback to the instructor. However, if you have a issues or concerns, you should not wait until the end of the semester to talk to your instructor. Please come to me at any time. The feedback system is available at https://people.richland.edu/feedback.

myRichland

myRichland is the student information system portal and is located at https://my.richland.edu.

You may use it to find the course schedule, register for classes, check your grades, obtain unofficial transcripts, review financial aid, and other student services.

Library

The Learning Resources Center (LRC) has print and electronic resources available. They offer research assistance and information literacy sessions; they also have individual and group study areas.

Student Success Center

The Student Success Center, in room N117, is designed to be a one-stop shop for most student services. These include advising and registration, career services, counseling services, financial aid, veteran affairs, student records, and the transfer center.

The Student Success Center has coffee and snacks available daily, school supplies such as paper, pens, and highlighters, and personal supplies such as toothpaste, toothbrushes, and cough drops.

A few other student services are located in other rooms of the main building. These include Campus Life, which supports new student orientation, clubs, organizations, and student leadership, and the TRiO program that offers academic and personal support to first-generation, low-income, and students with disabilities.

Office of Student Engagement

The Office of Student Engagement, in room C133, has a Snack Center to provide grab-and-go food for students who were short on cash while on campus or who did not have time to grab a meal before coming to campus. The office also has personal supplies such as condoms and menstrual products available for students.

The Gender Inclusive/Family bathroom and many women's bathrooms are also stocked with complimentary menstrual products.

Food Pantry

In addition to the snacks in the Student Success Center and the Office of Student Engagement, Richland has partnered with The Good Samaritan Inn to create The Pantry at Richland Community College. If you are a student facing food insecurity, please complete the referral form at http://bit.ly/2ykuGUL or visit the Student Success Center.

Directory of Student Services

The main phone number for Richland Community College is 217-875-7211 or 217-875-7200. This is an automated system available 24 hours a day.

Student Service	Location	Extension
Accommodations	C148	6379
Advising and Registration	N116	6267
Campus Life	C131	6243
Career Services	N103	6305
Counseling Services	N117	6267
Financial Aid	N117	6274
Library	C152	6303
Online Learning Support	W143	6376
Mathematics Enrichment Center	S118	6383
Student Employment	N103	6305
Student Records	N117	6257
Student Support Services/TRiO Program	C143	6440
Testing	N114	6238
Transfer Center	N117	6438
Tutoring	C148	6379
Veteran Services	N118	6205

Weekly Calendar

This course does not run on a calendar week basis. This chart is provided as a convenience for students who organize their life by calendar week.

Students will receive a separate daily calendar that contains the section numbers covered each day as well as the due dates for major activities. Due dates are also listed in Canvas.

Week 1, January 14–20. . . . . Introduction to Differential Equations

- Definitions and terminology
- Initial-value problems, existence and uniqueness of solutions
- Differential equations as mathematical models

Week 2, January 21–27. . . . . First Order Differential Equations

- Solution curves without a solution, direction fields
- Autonomous first-order differential equations
- Separation of variables

Week 3, January 28–February 3 . . . . First Order Differential Equations

- Linear equations, integrating factor
- Exact equations, potential functions (calc 3), substitutions to make exact
- Solutions by substitutions; homogeneous equations, Bernoulli equations, linear substitution

Week 4, February 4–10. . . . . First Order Differential Equations

- Euler's method
- Improved Euler, Runga-Kutta methods (RK4)
- Numerical solvers
- *Review and Exam 1: First Order Differential Equations*

Week 5, February 11–17 . . . . Higher Order Differential Equations

- Linear differential equations; initial-value and boundary-value problems, homogeneous equations, non-homogeneous equations,
- Linear independence, Wronskian, existence and uniqueness of solutions
- Reduction of order

Week 6, February 18–24 . . . . Higher Order Differential Equations

- Homogeneous linear equations with constant coefficients
- Undetermined coefficients – superposition approach

Week 7, February 25–March 3 . . . . Higher Order Differential Equations

- Undetermined coefficients – superposition approach, annihilator approach

- Variation of parameters

Week 8, March 4–10 . . . . Higher Order Differential Equations

- Cauchy-Euler equation
- *Review and Exam 2: Higher Order Differential Equations*

Spring Break, March 11–17

- No Classes

Week 9, March 18–24 . . . . Series Solutions

- Taylor series solutions
- Review of power series, shifting indices
- Solutions about ordinary points, recurrence relations

Week 10, March 25–31 . . . . Series Solutions

- Solutions about singular points, Method of Frobenius
- Special functions; Bessel's Equation, Legendre's Equation

Week 11, April 1–7 . . . . Laplace Transforms

- Definition of the Laplace transform
- Inverse transforms and transforms of derivatives, solving initial value problems

Week 12, April 8–14 . . . . Laplace Transforms

- Operational properties of the transform; translations on the s-axis
- Translations on the t-axis, unit step (Heaviside) function, piecewise functions
- Derivatives of a transform, transforms of integrals, convolutions
- Transforms of periodic functions, the Dirac Delta function

Week 13, April 15–21 . . . . Laplace Transforms

- *Review and Exam 3: Laplace Transforms*

Week 14, April 22–28 . . . . Systems of Differential Equations

- Solving systems of linear equations using elimination
- Solving systems of linear equations using Laplace Transforms
- Preliminary linear algebra theory; superposition principle, general solutions
- Existence and uniqueness of solutions
- Linear independence/dependence; Wronskian

Week 15, April 29–May 5 . . . . Systems of Differential Equations

- Homogeneous linear systems; distinct real eigenvalues, repeated eigenvalues, complex eigenvalues, eigenvectors
- Nonhomogeneous linear systems; undetermined coefficients, variation of parameters

- Matrix exponentials, nonhomogeneous solutions
- *Review and Comprehensive Final Exam*