Syllabus for Math 2250-1
Differential Equations and Linear Algebra
Spring 2014

Instructor: Professor Grant B. Gustafson

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Lecture: Daily except Thursday, 7:30 to 8:20 am, JTB 140.

Laboratory: Thursday 7:30 am or 8:35 am in JTB 140, as registered.

Course Web Site: http://www.math.utah.edu/~gustafso/

Office and phone: JWB 113, 801-581-6879

Office hours: After class daily works. Appointments welcome! See the JWB 113 posted hours, duplicated online at http://www.math.utah.edu/~gustafso/doorcardS2014.pdf.

Final Exam: JTB 140, Tuesday 29 April 2014, 7:30 am until 10:10 am.

Textbook: Linear Algebra and Differential Equations with Introductory Partial Differential Equations and Fourier Series, ISBN-13: 978-1-269-42557-5. This text is a hybrid of the three texts: Edwards and Penney, *Differential Equations and Linear Algebra 3rd Edition*; Edwards and Penney, *Elementary Linear Algebra*; R. Haberman, *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, 5th edition.* See below for **further references** and ISBN numbers of individual textbooks.

Course Design

This course will cover essential knowledge of differential equations and linear algebra as used in engineering applications. The course is structured into four lecture hours per week and one Lab hour per week.

The work you will complete in Math 2250 consists of fourteen (14) weekly homework packages, fourteen (14) weekly take-home quizzes and fourteen (14) weekly Thursday labs. Homework is turned in on Tuesday. Labs are turned in on Thursday. There are three (3) midterm exams on Friday, 50 minutes each, fixed dates Feb 14, Mar 21, Apr 18, and a comprehensive 120-hour final exam on Tuesday Apr 29.

Exceptions to the due dates and exam dates will be posted at the course web site. In addition, email will be sent to the email address recorded (by you) at the Registrar's web site. This includes unpredictable events, especially unplanned no-lecture days and university-excused snow days.

Details about the content of each assignment type are as follows:

- **Homework (14) and Quiz (14), total 20%**: About three textbook sections of **textbook exercises** are due every Tuesday in **stapled package #1**, based on lecture sections covering through the preceding Friday. **Stapled package #2** due on Tuesday is the **Weekly Take-Home quiz**, delivered the preceding week. Credit for one quiz problem or one textbook exercise is identical. At the course web site and in the course syllabus you will see listings of assigned problems for the first package. All boxed problems in the PDF list will be graded. A small number of textbook problems will be dropped, about 7 problems out of 136. Only hardcopy assignments will be accepted. Work received late will be returned ungraded. **Late** means any day after the Tuesday due date. More precisely, any work not in the grader's stack will be returned ungraded. Missed homework or take-home quiz problems can be replaced by extra credit problems. See below.

- **Thursday Lab (14), total 10%**: Teaching Assistant (TA) **Rebecca Terry** will direct a lab session every Thursday. A **lab project** (called a worksheet) is distributed in the lab and the TA will lead student group work. The lab project problems will provide guided practice with basic methods and longer in-depth problems with physical and engineering applications. A minor number of problems will use computer assist. Credit is applied to your record for lab attendance and the completed worksheet. A lab project will take additional time outside of lab to finish. The TA will be available for additional office hours in a College of Engineering tutoring lab, located in building WEB. Hours and locations are communicated by email and in the lecture and lab meetings.

- **Midterm exams (3), total 40%**: Three 50-minute midterm exams will be given on select Fridays, fixed dates Feb 14, Mar 21, Apr 18. The exam starts at 7:10 am to allow for extra time. A practice exam with solutions will be posted a week prior to the midterm. Questions about the practice exam may be asked in the lecture, in the lab section, during office hours, by email and telephone.

- **Final exam (120 minutes), total 30%**: A 120 minute comprehensive exam will be given at the end of the semester. A practice final will be posted a week prior. Please check the final exam date and time against your schedule:

  Final Exam: JTB 140, Tuesday 29 April 2014, 7:30 am until 10:10 am.

  It is your responsibility to make yourself available for that time. Please make any arrangements (e.g., with your employer) as early as possible.

- **Letter grades** are determined as follows:

  1. Scores are normalized to scale 0 to 100. For example, there are 3 midterm scores Mid_1, Mid_2, Mid_3, each 0 to 100, and the midterm exam score is the average of the three scores,
  $$\text{Midterms} = \frac{\text{Mid}_1 + \text{Mid}_2 + \text{Mid}_3}{3}.$$
  2. Grades are computed as a weighted average comprising 20% homework and take-home quiz average, 10% for lab participation and completed projects, 40% midterm exam average, and 30% the final exam score. The formula is
  $$X = \frac{20}{100}(\text{HW}) + \frac{10}{100}(\text{Lab}) + \frac{40}{100}(\text{Midterms}) + \frac{30}{100}(\text{Final}).$$
  3. If X is your percentage grade, then your **guaranteed letter grade** in the course is given by the scale below. Letter grade assignments are decided from the whole record, not by a computer translation of numbers to letters. At posting of the final letter grade to the Registrar, a human element is inserted, which considers what was learned in 16 weeks, versus other events along the journey to the final exam.

  Grading Scale: The internally-used scale is uses GPA increments, which step 1/3 from $0.0 = E$ to $4.0 = A$. Briefly, $A = 95$, $B = 82$, $C = 67$, $D = 52$. In detail:

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A  = 95-100, A- = 90-94, B+ = 85-89, B  = 80-84,
B- =  75-79, C+ = 70-74, C  = 65-69, C- = 60-64,
D+ =  55-59, D  = 50-54, D- = 45-49, E  = 0-44.
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- **Rank-in-Class** is determined only by the exams. Rank 1 is the best, determined by sorting high to low on the exam average
  $$\text{Exam}_{\text{Ave}} = 100\left(\frac{40}{100}(\text{Midterms}) + \frac{30}{100}(\text{Final})\right).$$
  There is no influence on class rank from homework, take-home quizzes or Thursday labs.

- **Students with disabilities**:

  The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, then please notify the Center for Disability Services, 162 Olpin Union Building, 801-581-5020 (V/TDD). CDS will work with you and your instructors. All information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

A personal note: I will make accommodation. Please tell me what is needed and I will complete the CDS paperwork. Call 801-581-6879 or send email to `ggustaf@math.utah.edu` .

Learning Objectives for 2250

A goal of Math 2250 is to master the basic tools and problem solving techniques important in differential equations and linear algebra. These basic tools and problem solving skills are described below.

The Essential Topics

Be able to model dynamical systems that arise in science and engineering, by using general principles to derive the governing differential equations or systems of differential equations. These principles include linearization, compartmental analysis, Newton's laws, conservation of mechanical energy and Kirchhoff's circuit laws.

Learn solution techniques for first order separable and linear differential equations. Solve initial value problems in these cases, with applications to problems in science and engineering. Understand how to approximate solutions even when exact formulas do not exist. Visualize solution graphs and numerical approximations to initial value problems via slope fields.

Become fluent in matrix algebra techniques, in order to be able to compute the solution space to linear systems and understand its structure; by hand for small problems and with technology for large problems.

Be able to use the basic concepts of linear algebra, including linear combinations, span, independence, basis and dimension, to understand the solution space to linear algebraic equations, linear scalar differential equations, and linear systems of differential equations.

Understand initial value problems for first order linear differential equations, and corresponding initial value problems for higher order linear differential equations and systems of nonlinear differential equations.

Learn how to solve constant coefficient linear differential equations via superposition, particular solutions, and homogeneous solutions found via Euler's characteristic equation. Apply these techniques to understand the solutions to basic mechanical and electrical oscillation problems, forced and unforced.

Learn how to use Laplace transform methods to solve linear differential equations, with an emphasis on initial value problems for mechanical systems and electrical circuits.

Be able to find eigenvalues and eigenvectors for square matrices. Apply these matrix algebra concepts to find the general solution space to first and second order constant coefficient homogeneous linear systems of differential equations, especially those arising from compartmental analysis of mechanical systems and electrical networks.

Understand and be able to use linearization as a technique to classify the behavior of nonlinear autonomous dynamical systems near equilibrium solutions. Apply linearization, phase portrait analysis and stability theorems to a system of two first order non-linear differential equations. Examples include nonlinear models for interacting populations, the nonlinear pendulum and hysteresis in the Van der Pol oscillator.

Develop your ability to communicate modeling and mathematical explanations and solutions, using computer software such as Maple, Matlab, Mathematica and internet-based computer tools.

Problem Solving Fluency

Students will be able to read and understand problem descriptions, then be able to formulate equations modeling the problem usually by applying geometric or physical principles. Solving a problem often requires specific solution methods listed above. Students will be able to select the appropriate operations, execute them accurately, and interpret the results using numerical and graphical computational aids.

Students will gain experience with problem solving in groups. Group efforts promote the transformation of problem objectives into appropriate problem solving methods, through collaborative discussion. Students will learn how to articulate questions effectively with both the instructor and TA, and be able to effectively convey how problem solutions meet problem objectives.

Strategies for Success

Recommendations from Course Organizers

- Read the relevant text book sections *before* attending class. Ask questions and become involved.
- Work on the homework daily.
- Know how grades are computed at the start of the semester and plan accordingly.
- Create or join a study group with your classmates.
- Utilize the **Mathematics Tutoring Center** in building LCB.
- Visit the instructor and the TA during office hours.

My Recommendations

The above recommendations apply. In addition:

- Scan a section quickly to identify the main ideas and methods. As you read, catalog the worked examples.
- Read each assigned problem, as though it was a worked example. Add the problem types to the catalog of worked examples, details delayed. Especially, closely examine **all** recommended problems, not just the ones to be submitted. This is reading, not problem solving.
- Determine the easy problems from the list. Find a path for solving them, without writing anything. Mark the more difficult problems, to be solved later.
- Chase down the details. Background courses like algebra and calculus require a focused, channeled review when a problem knocks you down. This plan reduces the number of bruises in future weeks.

Tutoring: The Math Department Tutoring Center, also called the *Math Center*, is located in the basement of building LCB. Free tutoring is offered Mon–Thu from 8 a.m. to 8 p.m., and from 8 a.m. to 6 p.m. on Friday. Some, but not all of the math tutors welcome questions from Math 2250 students. To see the times and specialities of various tutors, consult the web address

`http://www.math.utah.edu/ugrad/tutoring.html`.

Texts:

Hybrid for 2250 and 3140: *Linear Algebra and Differential Equations with Introductory Partial Differential Equations and Fourier Series*, ISBN-13: 978-1-269-42557-5. The bookstore sells this hybrid edition, which bundles Edwards-Penney 3/E with Haberman 5/E, the latter for courses 3140 and 3150. This is the official required textbook.

Supplements: Sections 3.7 and 7.6 will be used, from the Edwards-Penney text *Differential Equations and Boundary Value Problems*, the current Math 2280 textbook, any edition. These sections cover *electrical circuits* and extra *Laplace transform* material. Copies will be made available of these two short sections.

Alternative text: *Differential Equations and Linear Algebra*, by C.H. Edwards Jr. and David E. Penney, 2009 Third Edition, ISBN-10: 0-13-605425-0. New problems and text material appear in the third edition. The bookstore may not stock it. The hybrid book includes all chapters of this textbook.

Online References: Site `http://www.math.utah.edu/~gustafso/` has pdf and text documents that can be printed from a modern web browser. Author: G.B. Gustafson. The notes and slides may be freely viewed and printed. The typeset material is from Gustafson's 900 page book, *Applied Differential Equations and Linear Algebra*, Copyright 1999-2014, as yet unpublished.

Student Solution Manual: The Edwards and Penney text *Differential Equations and Linear Algebra, 3/E* has a separately purchased student solution manual. Some textbook bundles from the publisher include the solution manual.

Cliff's Notes: Title *Differential Equations*, Cliff's Notes series, contains concise examples and readable explanations of topics found in the Edwards-Penney text.

Illegal copies: It is illegal to xerox a whole textbook. It is illegal to download a PDF copy of a whole textbook. These sentences are inferred from university copyright policy, online at `http://regulations.utah.edu/research/7-013.php`.

Prerequisites

Math 1210 and 1220 or the equivalent (Calculus I and II). This is first-year Calculus, with a very brief introduction to linear differential equations. Engineering programs fulfill the requirement with Engineering Calculus 1310-1320 and Accelerated Engineering Calculus 1321. In addition, background is required in planar curves, velocity and acceleration vectors from Physics 2210 or Math 2210 (Calculus III), or their equivalent courses. The co-requisite is Physics 2210, with actual use of physics minimal. There is use made in the course of partial derivatives, the Jacobian matrix and the chain rule in several variables.

Computer Assist

Computer code examples are supplied in Waterloo's `maple` computer algebra system. Examples are duplicated when possible for the MathWork's `matlab` numerical workbench.

A passive knowledge of `Maple`, `Matlab` or `Mathematica` is assumed from about the second week of the course. If you are new to computer algebra systems and numerical workbenches, then explore the online tutorial links at the course web site.

Further help with computers can be obtained in the Math Center, director Aryn Dejulius. Her web page is `www.math.utah.edu/ugrad/tutoring.html`. Contact info: office MC 155A in building LCB next to the Math center, phone 801-585-9478, email `dejulis@math.utah.edu` .

Persons without computer training and no technology-assist experience can survive through Chapter 2 with a graphing calculator and Microsoft's `Excel`. These tools are useful also for those with programming talent. Everyone should learn some examples for `Wolfram Alpha`, found by Google search from an internet browser, which answers natural language questions.

LCB Math Center

Free tutoring is available in the LCB tutoring center 8:00 a.m. to 8:00 p.m. daily, except until 6:00pm on Friday, closed weekends and semester holidays. Some maple help is available. Only a few of the tutors are capable of helping you on computer projects or on 2250 homework problems. The work hours of those individuals can be found by browsing the **Math Center web page**, located in the undergraduate link at `http://www.math.utah.edu/`

Midterm Exam Details

The exams are modeled after the sample exam, which is supplied on the web site, updated at least one week before the exam date. Available on the web page are old exams and solution keys, including all midterm and final exams for the last three years. You may print these for reference. The final exam has a separate study guide, also available at the site.

Books, tables, notes, cell phones, tablets, earphones and calculators are not allowed on exam day.

An in-class Midterm exam has different presentation rules, and none of the textbook problem suggestions apply in this case. Basically, the in-class exam is a first draft. No answer checks are expected. Answers count 25% and details count 75%.

Final Exam Details

Two hours are reserved for this written exam. As published by the university:

7:30 class: Tuesday, April 29, 2014 at 7:30am until 10:10am in the regular classroom.

The final exam is comprehensive. It covers explicitly chapters 1, 2, 3, 4, 5, 6, 7, 9 and 10 with weight distributed evenly across the chapters listed. A study guide consisting of problem types by chapter plus several final exam solution keys for previous final exams appear at the web site. There is explicit contact on the final exam with chapter 1 and 2 topics, but there are no matching problems on final exam online solution keys dated 2013 or earlier.

Notes, calculators, tables, books or aids of any kind are **not allowed** on the final exam. Please bring pencils, eraser and a university ID. Paper will be supplied.

Due Dates, Extra Credit, Late Work, Withdrawal

Due Dates

Due dates are updated dynamically at a link on page

`http://www.math.utah.edu/~gustafso/s2013/2250/index2250S2014.html`.

Browse this site often. To repeat: **the due dates are not given in class**! Email communication will be made for due date changes and upcoming exams. The registrar's list is used for communication.

Please prepare submitted work according to the tentative schedule of due dates. The actual due date is the same date, or one day later, as documented on the web site. This adjustment is needed for snow days and unforseen events, so it happens infrequently.

Email Notification

You will be sent email about due dates, exam reviews and exam dates during the semester. This service depends on your email address being up to date.

Look up your campus information data by visiting the registrar's campus WWW site (where you add classes). Find out your email address, then test it by emailing a message to yourself. To update the information, return to the registrar's site and edit your personal data.

When is Work Late?

Due to the number of problems being collected, work is considered late and therefore unacceptable when the stack of papers exits 113 JWB and goes to the grader. Papers not in the stack get a zero recorded for the assignment.

Are you an exception? It is better to ask than to assume anything. Depend on extra credit problems (see below) to make up for work not submitted on schedule. The same advice applies, if submitted work earns a grade of 50% or 0. While a zero generally means no work was submitted, graders sometimes reject a paper completely and mark it zero, as though nothing was submitted. You'll get the paper back and maybe an explanation of why they did that.

The state of submitted work is locked at the point the grader gets the stack. A grader's job is to filter out the good work from the bad work and record the result. This record is never appended, it is only corrected for errors.

The lowest ten (10) problems are dropped from consideration in order to expedite mediation of missing work. There is no distinction between a problem from the textbook, a take-home quiz problem, a maple / matlab / mathematica problem or an Extra Credit problem. All earn the same credit.

If you have more than fifteen (15) zero scores, then please call 801-581–6879 or email `ggustaf@math.utah.edu` and discuss the situation and options for completing the work.

Withdrawal

It is the Math Department policy, and mine as well, to grant any withdrawal request until the University deadline. This promise also means that such a withdrawal requires no explanation. Withdrawals are always initiated by the registered student. All paperwork is the duty of the student. My job is the signature.

Purpose of the Textbook Problems

The *purpose* of the problems is to practice doing mathematics, that is, to write out in detail the solutions to problems. A textbook problem is generally an engineering–style "crank" problem, usually devoid of proofs. The process:

- **Understand the Problem**. Understanding usually involves reading the *problem notes* and the textbook. Answers may not be provided. You may get an outline of the solution in class or on the WEB, to increase the probability that the project gets completed on schedule. Problems are discussed in class in finer detail, often with the aid of computer slides, which are mirrored at the web site as PDF files. Slides cover a similar problem or sometimes the exact problem considered in the project.

- **Background Reading**. To solve a problem, a second opinion of the theory and method is essential. It might be that you can flesh it out of your book's examples, the college algebra text, the calculus text or some engineering mathematics book. No matter, go to a source that works for you. This is *reading* and not a tutorial.

- **Scratch Paper Write–up**. The initial creation of a solution is the essence of the learning process. Everyone learns by repetition, and here is where you do it. Use a pencil and a big eraser, lots of paper, and flesh out a first draft at full speed. Don't submit this draft!

- **Final Copy**. The final copy of the solution uses the scratch paper draft as raw material to *present* the details of the solution. As such, it is more than a collection of formulas on paper. There is no strict requirement, except that *neatness* and *completeness* are a must.

- **Final Copy Format**. The most successful format to date was invented by several engineering mathematics students over the years 1990–2013. This format is described in some detail below and also in the internet document *format for submitted work*.

Suggestions for Improving Written Work

1. Use engineering paper or plain white paper. Lined notebook paper and graph paper are not acceptable for mathematics, because they introduce flaws in vertical white space.
2. Reports are hand-written in pencil. They start with a problem statement followed by the book's answer or by a final answer summary. Supporting material appears at the end, like a tax return.
3. Every report has an answer check. For problems with textbook answers, it is usual to see "*the answer matches the textbook*," or briefly **B.O.B.**, for *back of book*. For problems without a textbook answer, a full answer check is expected.
4. Mathematical notation is on the left, text on the right, about a 60% to 40% ratio. One equal sign per line. Justify equations left or align on the equal signs.
5. Text is left-justified on the right side. It includes explanations, references by keyword or page number, statements and definitions, references to delayed details, like long calculations, graphics and answer checks.
6. Items **1**, **2**, **3** are expected elements of a report. Freely modify suggestions **4** and **5**. They are suggestions, not rules.

Cooperative efforts are allowed and encouraged. Kindly produce individual handwritten reports. There is no penalty for getting help from others – it is encouraged. This includes tutorial staff in the Math Center LCB, teaching assistants and fellow students.

English language deficiencies are tolerated but not excused. Graders prefer short, precise English comments. If English is your second language, then try to improve your writing skills: (1) shorten comments and (2) use specific references to the textbook.

Presentation is expected to improve throughout the 15 weeks of the course. You are not expected to be an expert in the first week. Correctness of answers will be checked. The problem notes might contain answers plus a solution outline. In class, further details are communicated. Your job is to *improve* on the initial start into the solution. Add the particulars, make comments, and chase down the details from algebra and calculus. College algebra and calculus skills need constant and careful review. Writing up the solution identifies the stumbling blocks and forces a review of background material.

References are required on the first occurrence. After that, omit the citation. It is appropriate to refer to the previous assignment on which the citations originated. A statement like *References parallel Exercises 1-5* is enough.

Extra credit instructions

Extra credit problems are only available in PDF format at the course web site. They do not appear in the textbook or in this syllabus. It is possible, because of them, to earn 100% credit on each homework.

Location. The web site `http://www.math.utah.edu/~gustafso/` has a 2250 link to PDF files for all extra credit problems, one PDF file for each chapter.

Rule 1: Extra credits from Ch1 to Ch5 apply only to that chapter. These chapters are collected on April 9.

Rule 2: Extra credits from Ch6 to Ch10 apply to any missing score. These chapters are collected on April 30 (during final exam week).

Grades on extra credit problems are 100 and 0. Generally expect an extra credit problem to be more difficult than the standard assignment.

Which problems should I work? You can choose whichever extra credit problems that you want, to replace scores of 50 or 0, within a given chapter. Just because you missed `1.2-2` is no reason to work `Xc1.2-2`. Instead, choose a problem from the extra credit problems for chapter 1 that can extend your knowledge or help you to prepare for exams. My advice is to beat on problems you missed, because missing a problem is usually a wake-up call. If it was just a silly mistake, like miscopying the problem statement, then choose a different problem.

To illustrate **how credit is applied**, suppose that chapter one has 15 homework problems and 5 extra credit problems. Consider this record:

Problem Count	Score	
9	100	successful problems
3	50	problems with demerits
3	0	failed problems
4	100	successful extra credit

Then the average on chapter one is the smaller of $(9*100+3*50+4*100)/15 = 96.67$ and 100. The fifth extra credit problem could add 100 to the total, then the average is 100%.

Another example:

> Standard problems might total 1600 for a chapter, which is the count for 16 problems. Extra credit problems could potentially add 5 times 100 or 500. If 1350 was earned on standard problems, plus 300 on extra credit, then the total earned is $(1350+300)/16 = 103.125$. This total is truncated to 100, because you may earn no more than 100% for a chapter.

Submissions. Please submit extra credit problems with a special label. To illustrate, extra credit problem **1.2-12** would be submitted with label $\boxed{\textbf{XC1.2-12}}$. Your name on the top of the page and the course 2250-1 is sufficient, no ID number required.

Deadlines. There are two deadlines for submitting extra credit work: April 9 for chapters 1 to 5, and April 30 (during final week) for chapters 6 to 10X. The extra credit stack is delivered on these dates to a grader. The records are locked by the grader and never appended, only corrected. Without the help of graders, the extra credit cannot be counted. Please adhere to the schedule, it is absolute.

Week-by-Week Guide of Textbook Sections and Homework Due

The topic schedule is subject to slight modifications as the course progresses, but the exam dates are fixed.

Abbreviations:

EP = Edwards-Penney, Differential Equations and Linear Algebra
EPbvp = Edwards-Penney, Differential Equations and Boundary Value Problems
EPH = Edwards-Penney-Haberman hybrid textbook 2013 (the required textbook)
DE = Differential Equation
ODE = Ordinary Differential Equation
$\boxed{12}$ = Means problem 12 is to be submitted for grading.

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WEEK 1, Jan 6-10
======
1.1; differential equation, mathematical model.
1.2; integral as a general or particular solution.
1.3; slope field.
1.4; separable differential equation.
Take-home Quiz1 and Homework HW1 due next Tuesday.
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WEEK 2, Jan 13-17
======
1.5; linear differential equation.
EPbvp 3.7; LR and RC circuits.
2.1, 2.2, 2.3; mixture model, population model, cascades, equilibrium solution, stability, acceleration-velocity models.
Take-home Quiz2 and Homework HW2 due next Tuesday.

WEEK 3, Jan 20-24
======
Monday Holiday, Martin Luther King. No classes.
2.3; escape velocity, Jules Verne problem.
2.4, 2.5, 2.6; numerical solutions.
Take-home Quiz3 and Homework HW3 due next Tuesday.

WEEK 4, Jan 27-31
======
3.1, 3.2, 3.3; linear systems, matrices, Gaussian elimination;
Take-home Quiz4 and Homework HW4 due next Tuesday.

WEEK 5, Feb 3-7
======
3.4; reduced row echelon form.
3.5; matrix operations, matrix inverses.
3.6; determinants.
Take-home Quiz5 and Homework HW5 due next Tuesday.
Study Sample Exam 1 for next Friday.

WEEK 6, Feb 10-14
======
4.1; vector spaces, linear combinations in R^n.
4.2; span and independence.
4.3; subspaces.
Friday Exam 1 over Weeks 1, 2, 3, 4.
Take-home Quiz6 and Homework HW6 due next Tuesday.

WEEK 7, Feb 17-21
======
Monday Holiday, President's Day. No classes.
4.4; bases and dimension.
4.7; abstract vector spaces and solution space of a DE.
5.1, 5.2; second-order linear DE, general solutions, superposition.
Take-home Quiz7 and Homework HW7 due next Tuesday.

WEEK 8, Feb 24-28
======
5.3; constant coefficients.
5.4; mechanical vibrations, pendulum model.
5.5; particular solutions to non-homogeneous problems.
EPbvp 3.7; circuits.
Take-home Quiz8 and Homework HW8 due next Tuesday.

WEEK 9, Mar 3-7

======
5.6; forced oscillations, resonance and mechanical vibrations.
10.1, 10.2, 10.3; Laplace transforms, solving a DE with transforms.
Take-home Quiz9 and Homework HW9 due next the Tuesday after Spring Break.
Study Sample Exam 2 for March 21, the next Friday after Spring Break.

WEEK 10, Mar 8-16 is Spring Break. No classes.
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WEEK 11, Mar 17-21
=======
10.4; partial fractions and translations.
10.5; Unit step, ramp, convolution.
EPbvp 7.6; impulse response.
Friday Exam 2 over Weeks 5, 6, 7, 8.
Take-home Quiz10 and Homework HW10 due next Tuesday.
WEEK 12, Mar 24-28
=======
6.1; eigenvalues and eigenvectors.
6.2; diagonalization
6.3; power method.
7.1; intro to first-order systems of ODE.
Take-home Quiz11 and Homework HW11 due next Tuesday.

WEEK 13, Mar 31 to Apr 4
=======
7.2; Matrix systems of DE
7.3; eigenanalysis method, spring systems, forced undamped systems.
Take-home Quiz12 and Homework HW12 due next Tuesday.

WEEK 14, Apr 7-11
=======
7.4; systems and practical resonance.
9.1; equilibria, stability.
9.2; phase portraits for non-linear systems.
Take-home Quiz13 and Homework HW13 due next Tuesday.
Study Sample Exam 3 for next Friday.

WEEK 15, Apr 14-18
=======
9.3; populations and ecological models;
9.4; nonlinear mechanical systems,
Friday Exam 3 over Weeks 9, [Week 10=break], 11, 12, 13 (last exam).
Take-home Quiz14 and Homework HW14 due by next Monday 28 April under the door JWB 113.
Study Sample Final Exam

WEEK 16, Apr 21-23
=======
Sample Final Exam.
Comprehensive Final Exam review.
Study Sample Final Exam

WEEK 17
=======
Finals week: comprehensive final exam, 7:30-10:00 a.m. in JTB 140.

HW 1
1.1: 1, 4, 5, 6, 9, 15, 19, 27, 29, 30, 32, 33, 34
Reading. Required background.

1.2: 1, $\boxed{2}$, $\boxed{4}$, 5, $\boxed{6}$, 7, 9, $\boxed{10}$, 13, 15, 16, 18, 21, 22, 24, 26, 29, 31, 32, 33, 35, 40, 41

1.3: 2, 3, 5, 6, $\boxed{8}$, 10, 11, 13, $\boxed{14}$, 23, 25, 26, 33

1.4: 2, 3, 4, $\boxed{6}$, 9, $\boxed{12}$, 13, $\boxed{18}$, 19, 20, 21, $\boxed{22}$, $\boxed{26}$, 36, 41, 42, 45, 46, 49, 51, 56, 59

HW 2
1.5: 1, 7, $\boxed{8}$, $\boxed{10}$, 13, $\boxed{18}$, $\boxed{20}$, 21, 23, 24, 33, $\boxed{34}$, 36, 39

EPbvp 3.7: 1, 2, $\boxed{4}$, 7 [RC and LR circuits, RLC after 5.6]

2.1: 1, 3, 4, 6, $\boxed{8}$, 10, 12, $\boxed{16}$, 22, 23, 33, 37

2.2: 5, 7, 8, 9, $\boxed{10}$, 11, 15, 17, $\boxed{18}$

2.3: 2, 3, 9, $\boxed{10}$, 13, 14, 17, 18, 19, $\boxed{20}$, $\boxed{22}$, 24

2.3: 25: escape velocity

HW 3
2.4: 2, 3, 4, $\boxed{6}$, 10, 12, 17 Euler's method

2.5: 3, 4, 5, $\boxed{6}$, 10, 12 improved Euler or Heun

2.6: 3, 4, 5, $\boxed{6}$, 10, 12 Runge-Kutta
Submitted as a computer project using a capable programming language.
Instructions are at the course web site: numericalDEproject-S2014.pdf

HW 4
3.1: 1, 4, 6, 7, $\boxed{8}$, 9, 11, $\boxed{12}$, $\boxed{16}$, 17, 19, 23, 24, $\boxed{26}$, 27, 28, 29, 32, 33, 34

3.2: 7, 8, 9, $\boxed{10}$, 13, $\boxed{14}$, 15, 17, 20, 21, $\boxed{24}$, 25, 29, 30

3.3: $\boxed{10}$, 11, 13, 17, 19, $\boxed{20}$, 33, $\boxed{34}$, 35

HW 5
3.4: 3, 5, 7, 10, 11, 13, 16, 19, 21, $\boxed{22}$, 27, $\boxed{30}$, 31, 32, 33, 34, 35, $\boxed{36}$, 39, $\boxed{40}$, 44

3.5: 5, 7, $\boxed{14}$, 17, 23, 25, $\boxed{26}$, 33, 43, $\boxed{44}$ or $\boxed{\text{Xc3.5-44a}}$

3.6: 3, 5, $\boxed{6}$, 11, 17, $\boxed{20}$, 21, 25, 29, $\boxed{30}$, 33, 30, 31, 37, $\boxed{40}$, 51, 53, $\boxed{60}$

HW 6
4.1: 1, 7, 9, 11, 15, 16, $\boxed{18}$, $\boxed{20}$, 22, 23, 25, 26, 27, $\boxed{32}$, 33-36

4.2: 3, $\boxed{4}$, 5, $\boxed{6}$, 7, 9, 11, 15, 17, $\boxed{18}$, 21, 24, 27, $\boxed{28}$, 29

4.3: 1, 3, 6, 8, 9, 10, 11, 16, 17, $\boxed{18}$, 23, $\boxed{24}$, 25, $\boxed{34}$

4.4: 5, $\boxed{6}$, $\boxed{12}$, 21, $\boxed{24}$, 31

HW 7
4.5: 6, 9, 15, 19, 23, 24, 28: Not due.

4.6: 2, 3, 5: Not due.

4.7: 7, $\boxed{10}$, 11, $\boxed{12}$, 19, $\boxed{22}$, 25, 26

5.1: 1, 6, 10, 11, 12, 14, 17, 18, 27, 33, $\boxed{34}$, $\boxed{36}$, 37, $\boxed{38}$, 39, $\boxed{40}$, 41, $\boxed{42}$, 43, $\boxed{46}$, $\boxed{48}$, 53

5.2: 1, 2, 5, 8, 11,13, 16, $\boxed{18}$, 19, 20, 21, $\boxed{22}$, 23, 25, 26

HW 8
5.3: 3, 7, $\boxed{8}$, 9, $\boxed{10}$, 11, $\boxed{16}$, 17, 23, 27, 31, $\boxed{32}$, 37, 40

5.4: 3, 4, 5, 6, 10, 11, 15, 17, 19, $\boxed{20}$, 21, 33, $\boxed{34}$

EPbvp 3.7: 1, 2, 4, 7, $\boxed{12}$, 15, $\boxed{18}$, 19 [electrical circuits]

HW 9
5.5: 2, 3, 5, $\boxed{6}$, 10, 11, $\boxed{12}$, 19, 21, $\boxed{22}$, 25, 27, 29, 31, 34, 39, 43, 45, 47, 51, 52, $\boxed{54}$, 57, $\boxed{58}$, 59

5.6: 3, $\boxed{4}$, 5, 7, $\boxed{8}$, 9, 11, 13, 15, 17, $\boxed{18}$, 20, 21, 22

10.1: 1, 3, 7, 9, 11, 13, 17, $\boxed{18}$, 19, $\boxed{22}$, 23, 27, $\boxed{28}$, 29, 31, 40

HW 10

No HW 10. No Quiz 10. No Lab 10. Spring Break.

HW 11

10.2: 3, 7, 9, $\boxed{10}$, 15, $\boxed{16}$, 17, 19, $\boxed{20}$, 21, 23, $\boxed{24}$, 35, 37

10.3: 3, $\boxed{6}$, 7, 9, $\boxed{12}$, 13, 17, $\boxed{18}$, 20, 23, 27, 28, 29, 30, 32, 34, 37

HW 12

10.4: $\boxed{2}$, 3, 9, 13, 15, 17, $\boxed{22}$, 23, 26, 27, 29, 30, $\boxed{36}$, 37

10.5: 3, $\boxed{4}$, 7, 9, 11, 13, $\boxed{14}$, 21, $\boxed{22}$, 25, 27, $\boxed{28}$, 31, 33, 34, 37

EPbvp 7.6: 2, 5, 6, $\boxed{7}$, $\boxed{8}$, 11, $\boxed{12}$, 18, 21, $\boxed{22}$ [impulses and Laplace]

HW 13

6.1: 3, 7, 9, $\boxed{12}$, 13, 15, 17, 19, $\boxed{20}$, 21, 25, 27, 29, 31, $\boxed{32}$, 33, $\boxed{36}$, 37

6.2: 3, $\boxed{6}$, 9, $\boxed{20}$, 21, 23, 24, $\boxed{26}$, 27, $\boxed{28}$, 29, 31, 33, 37

7.1: 1, 3, 2, 5, 7, $\boxed{8}$, 11, 12, 15, 17, $\boxed{20}$, 21, 24, 26

7.2: 1, 3, 7, 9, $\boxed{12}$, 13, $\boxed{14}$, 16, 23, 25

HW 14

7.3: 3, 7, $\boxed{8}$, 11, 13, $\boxed{20}$, 21, 29, $\boxed{30}$, 31, 34, 36, 39, 43, 45, 49

HW 14

7.4: 2, 3, $\boxed{6}$, 8, 9, 12, 13, 14, 16, 17, 18, 21, $\boxed{24}$

HW 15

9.1: 3, $\boxed{4}$, 5, 7, $\boxed{8}$, 11, 15, 17, $\boxed{18}$

9.2: $\boxed{2}$, 5, 7, 9, $\boxed{12}$, 13, 17, 19, 21, $\boxed{22}$, 23, 29

9.3: 5, 7, $\boxed{8}$, $\boxed{9}$, $\boxed{10}$, 11, 18, 19

9.4: 1, 3, $\boxed{4}$, $\boxed{8}$, 9, 10, 11, 13, 14