MATHEMATICS 3150-4
Partial Differential Equations
Spring Semester 2014

Time: Mon-Wed 11:50am, WEB 1250

Instructor: Professor Grant B. Gustafson[1]

Office Hours: JWB 113, Mon-Wed after class. Appointment are appreciated. Other times appear on my door card. From computers, read the door card link Here.

Telephone: 801-581-6879 in 113 JWB. Please use email whenever possible.

Email: `ggustaf@math.utah.edu` .

Web site: `http://www.math.utah.edu/~gustafso/`

Tutoring: The Math Center, abbreviation MC, 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 math tutors can field questions about Math 3150 topics. To see the times and specialities of various tutors, consult the web address

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

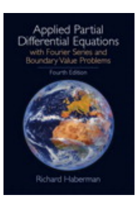
Texts:

Required Text. Edwards, Penney and Haberman, *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: Differential Equations and Linear Algebra 3/E, by Edwards and Penney; Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, 5/E, by Haberman; Elementary Linear Algebra, by Edwards and Penney. This version of the text is required for the 4th semester in the new engineering math sequence Math 3140 and the PDE course Math 3150.

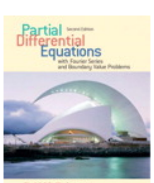
Haberman's Web Site. Available free from the author are `Matlab` sources for all figures in the book: Haberman's WEB site.

Alternate Haberman Text. Chapters 1, 2, 3, 4, 10 of Haberman 5/E are copied into the required hybrid textbook (see above). If you have no text already, then buying Haberman 4/E is the best plan. Know that 4/E has no resale value: it is recycle paper when you are done. Chapters 1, 2, 3, 4, 10 are the only chapters used in 3150, and they are the same whether from 4/E or 5/E.



Richard Haberman, *Applied Partial Differential Equations, 4/E*, Pearson (2003), 769 pages, ISBN-10: 0130652431. Publisher site Pearson Higher Ed.

Recommended Text. *Partial Differential Equations and Boundary Value Problems* 3/E, by Nakhlé Asmar.



Publication info: Hardcover 3rd edition (April 24, 2013), 671 pages, $45 from independent publisher lulu.com. Hardcover 2nd edition (May 24, 2004), Prentice Hall, 816 pages, ISBN-10: 0131480960, ISBN-13: 978-0131480964. Amazon has sold it (Nov 2012) for $49.00 used paperback and $19.00 used hardback. Prices should fall with 3/E on the market.

Asmar's Student Solution Manual. The second edition PDF manual is available for free from Asmar's site. Maple and Mathematica notebooks are available.

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[1] Pronunciation: In the phrase *Gust of Wind* replace *Wind* by *Sun*.

http://www.math.missouri.edu/~nakhle/pdebvp/student-manual.pdf

http://www.math.missouri.edu/~nakhle/pdebvp/maple-notebooks.html

http://www.math.missouri.edu/~nakhle/pdebvp/notebooks.html

WWW Documents for 3150. Browse the 3150 course web site Here.

All are pdf or text documents that can be printed from Mozilla Firefox, Google Chrome, MS-windows iexplorer, OS/X Safari and other web browsers that support printing of text and pdf files. Author: G.B. Gustafson. The notes and slides may be freely viewed and printed.

Prerequisites

Math 1210 and 1220 or the equivalent (Calculus I and II). A course in ordinary differential equations, 2250 or 2280. A course in linear algebra, 2250 or 2270. 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 (Phy 301 before 1998), with actual use of physics minimal. The course uses partial derivatives, the Jacobian matrix and the chain rule in several variables.

Persons without computer training and no maple experience can survive with a graphing calculator and Microsoft's `Excel`. The majority of the class will use MathWork's `Matlab` or Waterloo's `Maple`. Wolfram Research `Mathematica` is available with a campus-wide site license. If you know `Mathematica`, then please use it. For examples, see the `Mathematica` source code at Asmar's site.

A few presentations in 3150 will use computer algebra system `Maple`.

Computer code is supplied for many of Asmar's examples in `Maple`: Link Here. There are `Matlab` samples available, from Fernando Guevara-Vasquez in 2009 and 2012, written for Asmar's book: Link Here. Haberman's textbook 2013 has `Matlab` sources for all figures, from the author, at Richard Haberman's WEB site.

Course material and requirements

This course is an introduction to Fourier series, partial differential equations and the Fourier transform in engineering and science. Chapters 1, 2, 3, 4, 10 of Haberman's 4/E text and class notes published as WEB documents will make up the course material. If you study in isolation, then please know that all topics are enriched in class. Your grade in the course may be reduced by isolation, because the enriched material is tested on exams.

All page references are to the hybrid textbook Edwards-Penney-Haberman (EPH, 2013). Section numbers are for EPH. To translate to Haberman 4E or Haberman 5E, replace EPH chapters 12 to 16 by chapters 1,2,3,4,10.

Independent reading assignment

The week 2 lectures provide only a brief introduction. The main effort is individual, trying to provide background for reading Haberman's text.

EPH 4.6 *Edwards-Penney, Orthogonal Vectors 269*
Inner product, inner product space, orthogonal vectors, CSB inequality, triangle inequality, parallelogram law

EPH 4.10 *Edwards-Penney, Inner Product Spaces 299*
Inner product on a function space, CSB and triangle inequalities in an abstract inner product space, orthogonal projection onto a subspace with orthogonal basis, inner product definitions with various sets, trig polynomials, Fourier coefficients, approximation of time signals by trig polynomial projections

EPH 13.3 *Haberman, 2nd chapter Appendix, Orthogonality of Functions 763*
Mostly remarks here, requiring reading of Edwards-Penney sections EPH 4.6 to 4.10.

Daily Schedule for Spring 2014

CHAPTER 12 Heat Equation 717
WEEK 1, Jan 6, 8
12.1 Introduction 717
12.2 Derivation of the Conduction of Heat in a One-Dimensional Rod 718
12.3 Boundary Conditions 726
12.4 Equilibrium Temperature Distribution 728

WEEK 2, Jan 13, 15
12.5 Derivation of the Heat Equation in Two or Three Dimensions 733
12.6 Appendix to 1.5: Review of Gradient and a Derivation of Fourier's Law of Heat Conduction
EPH 4.6, 4.10, 13.3 Independent reading assignment.

CHAPTER 13 Method of Separation of Variables 744
WEEK 3, Jan 20, 22
Monday Holiday, Martin Luther King. No classes.
13.1 Introduction 744
13.2 Linearity 745

WEEK 4, Jan 27, 29
13.3 Heat Equation with Zero Temperatures at Finite Ends 747
13.4 Worked Examples with the Heat Equation (Other BVP) 765

WEEK 5, Feb 3, 5
13.5 Laplace's Equation: Solutions and Qualitative Properties 775
Exam Review, for weeks 1-4

CHAPTER 14 Fourier Series 791
WEEK 6, Feb 10, 12
14.1 Introduction 791
14.2 Statement of the Convergence Theorem 793
14.3 Fourier Cosine and Sine Series 796
Exam review and solved examples, weeks 5-6.

WEEK 7, Feb 17 ,19
Monday Holiday, President's Day. No classes.
EXAM 1, for weeks 1-6

WEEK 8, Feb 24, 26
14.4 Term-by-Term Differentiation of Fourier Series 813
14.5 Term-By-Term Integration of Fourier Series 822
14.6 Complex Form of Fourier Series 826

CHAPTER 15 Wave Equation: Vibrating Strings and Membranes 829
15.1 Introduction 829
15.2 Derivation of a Vertically Vibrating String 829

WEEK 9, Mar 3, 5
15.3 Boundary Conditions 832
15.4 Vibrating String with Fixed Ends 835

WEEK 10, Mar 8-16 is Spring Break. No classes.

WEEK 11, Mar 17, 19
15.5 Vibrating Membrane 840
15.6 Reflection and Refraction of Light and Sound Waves 843
Solved examples, wave equation.

CHAPTER 16 Infinite Domain Problems: Fourier Transform 848
WEEK 12, Mar 24, 26
16.1 Introduction 848
16.2 Heat Equation on an Infinite Domain 848
16.3 Fourier Transform Pair 852

WEEK 13, Mar 31, Apr 2
16.4 Fourier Transform and the Heat Equation 859
16.5 Fourier Sine and Cosine Transforms:
The Heat Equation on Semi-Infinite Intervals 870

WEEK 14, Apr 7, 9
16.6 Worked Examples Using Transforms 878, part I.
Exam review and solved examples, weeks 7-12.
EXAM 2, for weeks 7-12

WEEK 15, Apr 14, 16
16.6 Worked Examples Using Transforms 878, Part II.
16.7 Scattering and Inverse Scattering 897
Additional examples: Welding torch, Shannon's theorem on signals

WEEK 16, Apr 21, 23
Exam review for the final exam, weeks 1-13
Additional worked examples for heat, wave, Laplace and Poisson equations.

Homework

The hybrid text (EPH) is Edwards-Penney-Haberman, Differential Equations, Linear Algebra and Partial Differential Equations, special edition for the University of Utah (2013).

The Haberman text (H) is *Applied Partial Differential Equations*, edition 4E or 5E. Hybrid EPH is 5E. Only chapters H 1,2,3,4,10 are used, which are the same as EPH 12,13,14,15,16.

Certain exercises are re-written into course website PDF files. These exercises make up a reduced exercise list for each textbook section. A subset of the PDF exercises are submitted for grading. In general, a PDF exercise can be read independently of the textbook, and certainly independent of a textbook edition. In most cases, additional references are supplied, for example, to other standard textbooks on partial differential equations, physics texts and internet references. Details appear at the 3150 course website:

http://www.math.utah.edu/~gustafso/s2014/3150/index3150S2014.html

EXERCISES H 1.2 or EPH 12.2: 1, 2b, 4b, 7, 8
EXERCISES H 1.3 or EPH 12.3: 2, 3
EXERCISES H 1.4 or EPH 12.4: 1d, 1f, 1h, 2a, 4, 7a, 8
EXERCISES H 1.5 or EPH 12.5: 1a, 2, 3a, 3e, 7, 11, 13

EXERCISES H 2.2 or EPH 13.2: 2a, 2b, 4a, 4b
EXERCISES H 2.3 or EPH 13.3: 1a, 1c, 1f, 2b, 2c, 3c, 4, 5, 6, 7, 8
EXERCISES H 2.4 or EPH 13.4: 1, 2, 3, 4
EXERCISES H 2.5 or EPH 13.5: 1a, 1c, 1e, 2a, 3, 4, 5a, 5c, 6a, 7b, 9, 15b, 22

EXERCISES H 3.2 or EPH 14.2: 1b, 1d, 1f, 2a, 2c, 2f, 4
EXERCISES H 3.3 or EPH 14.3: 1a, 1d, 2a, 2d, 5c, 7, 10, 13, 18
EXERCISES H 3.4 or EPH 14.4: 1a, 2, 3a, 6, 8, 9
EXERCISES H 3.5 or EPH 14.5: 1c, 4, 7
EXERCISES H 3.6 or EPH 14.6: 1 [this section appears later in editions before 4E]

EXERCISES H 4.2 or EPH 15.2: 2, 5
EXERCISES H 4.3 or EPH 15.3: 1, 2
EXERCISES H 4.4 or EPH 15.4: 1a, 1b, 2c, 3b, 6, 7, 8, 9, 11, 13
EXERCISES H 4.5 or EPH 15.5: 1
EXERCISES H 4.6 or EPH 15.6: 3, 4

EXERCISES H 10.2 or EPH 16.2: 1, 2
EXERCISES H 10.3 or EPH 16.3: 1, 2, 3, 5, 6, 7, 11, 18
EXERCISES H 10.4 or EPH 16.4: 1, 2, 3a, 4a, 5c, 7c, 8, 11
EXERCISES H 10.5 or EPH 16.5: 1, 2, 3, 5, 10, 11, 12
EXERCISES H 10.6 or EPH 16.6: 1a, 2b, 3, 11a, 12a, 15, 18
EXERCISES H 10.7 or EPH 16.7: 1, 2

The 130 problems are distilled into about 70 PDF exercises to be submitted for grading.

The above list of 130 exercises is intended to be part of your reading program for Haberman's text. While no one expects you to work all the problems in this list, please plan on READING the problems.

Grading:

Final grades will be based on:

Textbook-style problems, with technology assist expected, called **homework**.

Two written midterm examinations.

A university-scheduled final exam. This in-class 2-hour examination counts as two additional midterm scores.

Written In-Class Exams:

There are two (2) midterm exams. There is a 2-hour in-class final exam as scheduled by the university. The midterm and final exams are graded by G.B. Gustafson and possibly one assistant.

Missed exams. Please send email to **ggustaf@math.utah.edu** or phone 801-581-6879 (office) or leave a message with Della Rae 801-581-6851. Please know that once you miss the exam, the crisis has ended, and recovery is the next plan. Please communicate ASAP.

Hand-written Homework:

There will be less than 70 required homework problems due during the semester, including textbook-style problems and technology-assisted problems.

Records and Email:

Accounting of exams and homework is initially on paper and ultimately by spreadsheet records. The electronic records are web-posted, through the university registrar's site, CANVAS link. Details will be sent to your email address recorded with the registrar. Please check to insure that your email address is current at https://gate.acs.utah.edu/

Homework, midterms and final

Textbook-style problems

The problems are not taken directly from the textbook. They are re-statements of textbook problems, independent of any edition of either Haberman's book or Asmar's book, distributed as a PDF file at the course web site. The homework is keyed to Haberman's textbook and Asmar's textbook by section number.

The problems to be submitted for grading are listed at the end of the syllabus, with tentative due dates. Visit the web site for extra copies of the syllabus and copies of the problems.

There are recommended textbook problems, taken from Haberman 4E. They are the same in Haberman 5E or the hybrid text Edwards-Penney-Haberman (2013).

A duplicate of the tentative due dates appears on the **due dates page** at the course web site. The actual due dates for problems appear only on this web page.

When to Submit Homework. Problems are submitted at the end of the Wednesday class, on the planned date. Exceptions will be announced by email. The stack will go to the grader on Friday afternoon, after the WEB 1250 problem session, weekly 11:50 to 1:00pm.

Participants in 3150 are asked to complete each textbook problem and submit their work in their own handwriting. Collaboration is encouraged on textbook problems in teams of 2 and study groups of a larger size. Submit a separate handwritten report for each partner. It would help the grader to assign scores fairly, to everyone in the group, if each of you would list the group members and package the submissions in order in the grader's stack (why should Guido score 96 and you get 91?).

Homework problems are written as one problem per package with your name, class time and a problem label. **Please write 11:50 or 3150 on your paper, next to your name, and insert a problem label**. Problem labels look like **1.2-3**, for problem 3 in section 1.2 of Haberman 4E. Page numbers depend on the edition of the book – **please don't use page numbers**!

When several problems are submitted together, then please construct a stapled package with the problems in order. Graders try to write the scores on the top page. This plan speeds up return of the work, so please use stapled packaging when it makes sense. No stapler? Just deposit your work in a stack without the staple. I'll add the staple in my office.

There are certain **suggestions** for writing up the textbook problems. A full accounting of the *format suggestions* contributed by students of 2250 and 3150 appears on the internet course page as a pdf document *format for submitted work*. Please apply to your written work the ideas found Here.

Computer Assist

There is a Math Department Computer Lab in building LCB, the `Math Center`, at which registered students automatically own accounts, and there are other unix labs around campus where `Maple` is also available, for example at the College of Engineering CADE lab. Most unix labs can launch remote tty sessions on math hosts using command `ssh user@xserver.math.utah.edu`. To operate in X-windows, replace `ssh` by `ssh -X` or `ssh -X -Y`. Remote files on math hosts can be transferred to your local unix computer with `sftp`. For information on how to do the same for personal computers, visit the campus computer help sites.

Midterm exam details

The exam will be designed from the sample exam, which is supplied a week before the exam date. A problem on the actual exam is guaranteed to have some spin, a change made to the sample exam problem.

Books, tables, notes and calculators are not allowed on exam day. The argument for this limitation is that complex arithmetic problems will not appear on exams, nor will you be asked to memorize huge tables of transforms or solution formulas.

An in-class Midterm exam has different presentation rules, and none of the homework problem rules apply in this case. Basically, the in-class exam is a first draft. No answer checks are expected.

Final exam details

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

11:50 class Friday, 25 April 2014, WEB 1250 at 10:15am until 12:45pm.

The final exam is comprehensive. It covers explicitly chapters 12, 13, 14, 15, 16 in EPH, which is chapters 1, 2, 3, 4, 10 in Haberman 4E or Haberman 5E, with weight distributed evenly across the five chapters. A study guide consisting of problem types and sample exam problems by chapter will appear at the web site before the last week of the semester.

No notes, calculators, tables, books or aids of any kind are allowed on the final exam. Please bring pencils and eraser. Paper will be supplied.

Due dates and late work

Due dates

Due dates are updated dynamically at site
http://www.math.utah.edu/ gustafso/s2014/3150/index3150S2014.html

Browse this site before the default **Wednesday due date**. Check your email for recent communications about due dates and exams. Due date changes may be made to account for snow days or canceled lectures.

When is work late?

Work is considered late and therefore unacceptable when the ungraded stack has been delivered to the grader. The state of submitted work is locked at the point when the stack is returned. This record is never appended, it is only corrected for errors.

Are you an exception? It is better to ask than to assume anything.

The lowest four (4) homework problems are dropped from consideration in order to eliminate makeups. That means 4 problems, not 4 packages. There is no distinction between a textbook-style math problem and a technology-assisted problem, they earn the same credit.

If more than ten (10) problems have zero scores, then please email **ggustaf@math.utah.edu** or call 801–581–6879 (office) to discuss the situation and find 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 a registered student. All paperwork is the duty of the student. My job is the signature and I will sign it.

ADA statement

The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact me at the beginning of the semester to discuss accommodation (113 JWB or 581-6879), which is to say, accommodation shall be made.

Grading details

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.
```

Final grade

The letter grade is determined from the *Grading Scale* above as follows:

$$\text{Final Grade} = \frac{30}{100}(\text{Homework Ave}) + \frac{70}{100}\frac{\text{Mid1+Mid2+2*Final}}{4}.$$

An example: the Homework Average for 65 textbook problems and maple labs is 91% and the Exam Average of the two midterms and the final exam is 87.5%. The final grade is $0.3(91)+0.7(87.5) = 88.55\%$, which by the scale above is a $B+$. While 88.55 rounds to 89, a $B+$, the deciding factor is really the exam average of 87.5, which is squarely a $B+$. The final grade is $B+$. If the Homework average was 95 or higher, then the final grade would be 89.75 or higher for a grade of $A-$. Similarly, a higher exam average would insure a final grade of $A-$.

A low homework average is not forgiven. It is important to say that a 50 percent homework average will prevent a final grade of A. This is because $0.3(50) + .7(100) = 85$, which is the lowest possible $B+$.

Engineering School Expectations

Mechanical, electrical and chemical engineering departments expect stellar performance in partial differential equations. They have asked for homework to be collected and graded. All of it, not some minimal portion of the total homework.

The various engineering and science departments served by 3150 decide the list of topics to be taught, not the math department. They also decide the textbook.

Graduation requirements of a **C-** or better in required math courses seem to be counter to departmental requests. Be advised that a grade of **C-** is viewed as a failure by all graduate schools and employers.

How homework is graded

Scores are assigned to homework problems as one of 100, 50 or 0. Based on grading history, about 90% of the scores on a given problem are 100%. A score of 0 is routinely given for work not submitted.

A grade of 100 usually means a complete, correct solution was written. Grading is normally generous, giving a 100 score when the solution method is correct, even if the details contain arithmetic errors and a few missing steps. Flaws in logic are not excused, even if the correct answer was found, due to multiple errors canceling the logic error.

A grade of 50 means the written work lacked essential details. This score is often given for a written solution with just the answer and a few sketchy details. Examples of sketchy solutions, worth 50 or 0 for a score, appear in textbook solution manuals. The naive assumption that the textbook's authors have supplied a solution to the problem in the manual is simply false: it is a solution sketch, by design devoid of essential details.

To submit a transcript of a solution manual as your own work is a desperate act. It is not cool.

The wrong answer is a reason for you to look for a flaw. Most answers are supplied, so if you get a different one, and you are correct, then justify your answer and I'll grumble quietly and eat worms.

Purpose of the assigned 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 textbook. Answers are usually not provided. You may be given an outline of the solution, to increase the probability that the project gets completed on schedule. Problems are discussed in class in finer detail. Slides cover a similar problem or sometimes the exact problem considered in the project. Classroom slides are mirrored at the web site as pdf files, ready to print from an internet browser.

- **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.

  Background reading includes the list of recommended textbook exercises. No one expects you to solve all of them, but you are expected to READ all of the problems, even more critically than you are reading the main text itself. It is in these problems that you will find the topics that you understand least, those topics which require a second reading and maybe some outside research.

- **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* located Here.

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. Kindly follow the advice, but know that graders are instructed to **NOT** deduct for format issues. It is important that you develop your own style. Ideas presented here are exactly that, they are ideas to be harvested. Please don't interpret the ideas as a collection of rules to be blindly followed.

Freely modify suggestions **4** and **5**. They are not rules, but a place to start, in case you don't yet have a style.

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.

Reports are individual efforts, but please write the group members on the report, and try to submit the group work asa unit, that is, papers in order in the grader's stack. The grader will try to assign equal credit for group work, provided you are kind enough to report the group members. Does Guido get 96 and you get 91? Prevent that from happening.

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.

Tentative Dates for 3150 Submitted Work S2014

Browse the course web site for problem statements (PDF files).

Policy on Homework: The lowest 4 of the 65 homework will be dropped (four problems, not four collections). Deadlines set at web site `www.math.utah.edu/~gustafso/`. Work not in the stack earns a grade of zero. Missed work can be replaced by Extra Credit work.

Policy on Exams: The final exam is doubled before determining the exam average, to count like two midterms.

Grading Scale:
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.