Math. 412, Sec. 200 (Honors) Fall, 2006

Partial Differential Equations

Classes: MWF 10:20–11:10, EP 212

Web page: `http://calclab.math.tamu.edu/~fulling/m412/f06`

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If I am not in my office, you can leave a note in my mailbox (in Blocker 603) or in the plastic pouch beside my office door.

Tentative office hours: M 2:00–3:00, W 1:00–2:00, R 3:00-3:45
Permanent office hours will be announced later.

Prerequisite: M. 308 or equivalent (differential equations). (M. 311 or other linear algebra will help, but is not required.)

Required textbooks:

1. R. Haberman, *Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems*, 4th edition, Prentice–Hall, 2004.
2. S. A. Fulling, Math 412 lecture notes, for sale at Copy Corner (2307 Texas Ave. S.).

Supplementary textbooks (not required)

There are many other textbooks on Fourier methods and PDEs. Here are two with a strong problem-solving orientation (i.e., many worked examples):

3. C. Constanda, *Solution Techniques for Elementary Partial Differential Equations*, Chapman & Hall/CRC, 2002 (used in Math. 401).
4. M. R. Spiegel (Schaum's Outline Series), *Fourier Analysis*.

And at the theoretical end, the most readable proofs of the theorems are in:

5. G. P. Tolstov, *Fourier Series*, Dover.

Grading system:

Hour tests:	$100 \times 3 = 300$
Final exam:	200
Homework and class participation:	200
Total	700

The "curve" will be at least as generous as the "standard" scale [i.e., 90% (= 630 pts) will guarantee an **A**, etc.].

Dates of hour tests: Fridays, Sept. 22, Oct. 20, Nov. 17.
Final exam: Tuesday, Dec. 12, 8–10 a.m.
Please bring your own paper for tests.

Class participation: We will sometimes discuss homework problems and other examples at the blackboard (or projector) in class. Sometimes I'll assign problems for you to work on in class in groups. At other times volunteers and random draftees will simply be called on. (You may also be called to the board to help me introduce a new concept or technique "Socratically". In such cases a good participation score is attained merely by being alert and cooperative.) Attendance records may influence class participation scores slightly.

Make-up tests: Make-up tests are very hard to grade fairly, and they absorb a large amount of my time which would be better spent for the benefit of the whole class. Please cooperate in making these incidents as rare as possible. If you miss (or foresee that you will miss) a test, it is *your* responsibility to contact me as soon as possible to request, justify, and schedule a make-up test. (If you can't reach me directly, you can leave a message at the Math Department office, (979) 845–3261.) If the absence is not clearly excused under the Attendance section of *Student Rules*, the request may be denied.

An Aggie does not lie, cheat, or steal or tolerate those who do. See Honor Council Rules and Procedures, `http://www.tamu.edu/aggiehonor` .

Plagiarism: Finding information in books or on the Internet is praiseworthy; *lying* (even by silence) about where it came from is academic dishonesty. Whenever you copy from, or "find the answer" in, some other source, *give a footnote or reference*. Otherwise, you are certifying that it is your own work.

Joint work: On a homework assignment (*not* a take-home test!) discussion with other students is permitted, even encouraged. However, the grader will not give homework credit for "work" that is parasitical (and your test scores will suffer, too!). To forestall problems, please follow these policies: (1) When two or more students work together on an assignment, they should all indicate so on their papers. (2) If the cooperation is of the divide-and-conquer variety, you are certifying that you *have studied and understand* every problem solution on your paper. Mindless copying is dishonest and academically worthless.

Calculators in exams: Calculators are to be used only to perform *elementary operations* such as addition, multiplication, and evaluation of simple functions such as square roots. Advanced facilities are prohibited, especially *storing formulas in memory* or executing programs to carry out algorithms that are part of the subject matter of the course. (Again, when in doubt, give a "footnote" describing what you did.) Violations of this rule may lead to total prohibition of calculators in exams (probably at the insistence of other students).

Copyright: Course materials (on paper or the Web) should be assumed to be copyrighted by the instructor who wrote them or by the University.

Disabilities: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845–1637.

Educational philosophy: Traditional homework assignments do little to develop the skills of communication, collaboration, and conceptual thinking that are expected of a modern college graduate in a technical field. The procedures in this class are designed to facilitate deeper learning. In part, this class is intended as a prototype of a "W course" (an addition to the Core Curriculum in which students get extra academic credit for writing experience). Lectures and routine homework assignments will be deemphasized. Instead,

class participation, careful and focused writing, constructive criticism of others' writing, and cooperative study will be encouraged. These activities are hard to grade by precise criteria; we will all be happier if you avoid a fixation on "points" and rest assured that the class participation and written work grades will be generous overall. **It is vital that you read the relevant sections of the textbooks and notes BEFORE coming to class, since the classes will often be used for discussion, not lecture presentation.**

We will be using the Internet and the World Wide Web for communications. Therefore, you will be provided with an account on the math department's `calclab` computer system (without paying an extra lab fee). Occasionally we may meet in one of the CalcLab classrooms for either mathematical demonstrations or computer access.

Groups: You'll be organized into groups of two or three. After each test the membership of the groups may be adjusted. The groups will serve two main functions: (1) reviewing homework papers (see below), and (2) working problems in class (see above).

Homework: As always, you are expected to work as many of the homework problems as you can, for the sake of learning. Indeed, you should try to finish the problems *well before* the "due date", so as to benefit from class discussion and to study for tests.

However, each week you will turn in *only two* homework problems (in some weeks, only one). Each of these is to be

> **a carefully written, complete, formal solution, comparable to a worked-out example in a textbook.**

In this way your class will build up its own solutions manual. For tips on good writing, please start by reading the attached "Guidelines for Reviewers (and Authors!)". Your paper should be self-contained, so you should either copy the problem from the book, or reformulate the problem briefly in your own words at the beginning of the solution (e.g., "We are asked to find a vector that satisfies ... ").

Problems may be individually assigned, or you may be allowed to choose one. In the latter case, roughly speaking, you should choose the hardest problem that you are confident you know how to do well.

For the time being, the limited availability of technology and lack of a standard format for electronic presentations forces us to continue to use paper as a medium of presentation. However, you can earn **2 extra points** per problem by making your work *also* accessible via the World Wide Web. Acceptable formats include:

1. plain ASCII text, using "pidgin TEX" for mathematical symbols. (An explanation of this will come later.)
2. HTML
3. PostScript
4. PDF

Optical scanning of a handwritten page is discouraged (worth only one extra point). The same is true of proprietary formats such as Microsoft Word (`.doc`) and raw TEX output (`.dvi`); output the file as HTML, PS, or PDF instead.

To avoid confusion and hassle for the grader, the following information must appear at the **top of the first page** of your paper:

Your name	Your calclab account name	
Assignment (week) number	Problem number	Indication if paper is *late* or *revised*
URL of the Web version of your paper (if it exists)		

(Please don't put your name, etc., on a separate cover sheet. That just wastes paper.)

You are strongly urged to keep a copy (or at least a rough draft) of your paper when you turn it in. Since your paper may be photocopied or put into a binder, *please follow these technical guidelines:* Use standard 8.5×11-inch paper, not too flimsy. Avoid yellow paper, blue pens, and faint pencil. Don't write too close to the edge of the page! (Leave margins of about an inch.) Use one side of the paper only. Use of word processors, especially TEX, is praiseworthy. (Note that Maple files can be exported as LATEX or as HTML.) We have LyX software to make TEX easy; more about this later.

Please note: Homework *authorship* in this class is *individual*. Your group membership is relevant only to *reviewing*. On the other hand, informal discussion with other students about homework problems is permitted, even encouraged. (That remark does not apply, of course, to anything announced as a take-home test.)

Getting credit for late papers will be hard — see below.

Reviewing: The adult world is not divided into students and teachers; it consists of diverse but comparable, fallible but mutually helpful, human beings. Similarly, a course at this level should not need a distinction between students and graders. Each week or so, your group will get all the papers turned in on one of the problems. **The papers are to be returned two class meetings later.** Meanwhile, the group should do the following (with my guidance, when necessary):

1. Write a review or critique of each paper, telling the author how it should be improved. (See "Guidelines for Reviewers (and Authors!)" attached below.)
2. Choose the best paper as the one to be "published" in your class's solutions manual (which will cover the even-numbered problems). Complications may arise here:
   (a) The best paper may not be good enough. Return it to the author (through the grader) with suggestions for improvements. (**A successful revision earns the author another one or two points.**)
   (b) You may choose more than one paper if they handle the problem in distinctly different ways, all of which are instructive.
   (c) The ideal paper may be a combination of pieces or elements from more than one paper. If possible, advise the grader how to do a "cut & paste" job on the existing papers. If necessary, invite the authors to submit a joint revised effort.
3. Write a summary report, suitable for the whole class to read, describing the results of the class's work on this problem. In particular, whenever appropriate:
   (a) Point out what is particularly good about the paper you chose — especially if you chose more than one.
   (b) Point out any mathematical errors that appeared more than once in the other papers. Avoid student names here. Remember that this report (but not the individual reviews) will end up on the Web!

The hope is that the summary report will be genuinely informative and useful (to the class, the grader, me, and even future classes). Therefore, its length will depend strongly on the circumstances. It might be as short as this:

> All 5 papers turned in were completely correct. We chose Jason Smith's paper because it was the neatest.

Or it might be like this:

> Marcia Kleberg's answer to part (a) is the best, but we thought the rest of her paper was unnecesssarily long and complicated. We didn't understand Bill Petersen's reasoning in (a), but he did a good job on parts (b) and (c). So we put together Marcia's (a) and Bill's (b)–(c). We think the result is better than any of the solutions inherited from previous classes!
>
> The other two papers we received both made a major mistake in part (c). ... [Explain what they did wrong. **In the long run, this will be the most valuable part of the report.**]

For real examples, see the reports on the Web pages from previous semesters of Math. 311 and 401 (and try to do better, of course).

4. The reviews and summary report **must** be e-mailed by means of the Homework Review Generator program on `calclab`. See the attached instruction sheet. This program was written by a student in Math. 311 in Spring '96 and makes the whole process much more efficient for you, the course grader, and me. (This does not mean that you must read e-mail directly on the `calclab` system; it is easy to create a `.forward` file to send the mail elsewhere. Nor does it mean that you need to do all your text editing for reviews on `calclab`; see part (E) of the program instructions.)
5. The list of group members on the summary report is a *signature* certifying that all listed members took part in the discussions leading to the reviews and report. Only members who (honestly) sign the report will get credit for reviewing. Some division of labor in the early stages of reviewing is appropriate, but all members should consult on the final decision and the summary report.
6. (optional) In a separate e-mail message, make any private remarks to the course grader that you consider appropriate. You *may* suggest point scores for the papers, or rank them, but that should not be your primary concern.
7. (optional) Consult the Undergraduate University Writing Center (on Floor 2 of Evans Library) for advice on the foregoing. Get a return on your $8/semester investment!

The grader and I will assign numerical grades to the problems (typical maximum of 10 points) and to the reviews and reports (maximum of 5 points per problem). Please note that the homework and reviewing scores will be *scaled* at the end of the semester to a reasonable distribution, with the result that a homework point will probably be worth only about half a test point.

After a homework problem has been collected and referred to a group of reviewers, late papers on that problem will be accepted only as a favor by the reviewers. If the reviewers have already finished their work, they should refuse to accept the paper, and the grader will give it minimal attention and probably only half credit.

Guidelines for Reviewers (and Authors!)

Write a tactful, but honest, critique of the paper. Here are some criteria to keep in mind, listed in decreasing order of importance. These goals may sometimes conflict. For example, brevity may interfere with pedagogical effectiveness, and both may conflict with completeness. The balance among them is a matter of judgment and taste.

1. **Mathematical correctness.** Any technical errors must be recognized and eliminated. Does every sentence make mathematical sense, or is the writer bluffing or showing off with mathematical terminology [s]he only partly understands?

2. **Completeness.** Has the author provided all the information needed to follow the argument or calculation from beginning to end? Has the author confused an example with an adequate treatment of the general case? (This does not mean that an example is not desirable; see 4.)

3. **Organization.** Are things said in the best order? Is the flow of the logic clear? Is the reason for each step clear? Are the main ideas in danger of being obscured by the details?

4. **Pedagogical effectiveness.** Has the author "gone the extra mile" to help the reader understand? Examples and analogies can add clarity to an already logically complete discussion. (Thus, this is primarily an opportunity to say something *positive* about the paper you're reviewing.)

5. **Sentence structure and punctuation.** Is the paper written in sentences, and does every sentence make sense? Help stamp out sentence fragments, run-ons, and dangling participles ("Adding x^2 to both sides, the answer becomes ... "). Has the writer left out or added a comma that unintentionally changes the meaning of the sentence (once famous example: "The Republican Party opposes any tax increase[,] which would harm the economy.")? Etc. ...

6. **Brevity and style.** Help the writer to trim out extra words, pointless repetition, and long transitional phrases that say nothing. Is pretentious language used where simpler language would do the job at least as well? Although mathematics seldom can read like a novel, some variety in word choice and sentence structure can stave off boredom.

7. **Grammar and spelling.**

8. **Neatness.** When asked to read something, you have a right to expect it to be legible. Few people can produce a good piece of formal writing without recopying the final draft. Use of a word processor or typewriter is encouraged but not required.

It is usually *not* necessary to comment specifically on each of these matters in a review. Concentrate on the most important things you have to say about the particular piece of writing at hand. Being relatively private, the reviews and summary report may be informally written, but they should still follow the principles of good writing.

We will use these "homework solutions" for a trial run of the homework review program during the first week. Give it the exercise number "0.0.0".

Question: What is a polynomial?

Some students' answers:

$\mathcal{ANDY}$: A polynomial is like $ax^2 + bx + c$.

$\mathcal{BETH}$: more than one member of a term with the unknown variable (such as x) part of the whole term with the exponents of the "x" term increasing as integers. Example: Polynomial is $9x^3 + 6x^2 - 3x + 1$.

$\mathcal{CHARLES}$: a polynomial is an equation where the variable has exponents that are always defined as the x^i and the a_i are never a fraction and whose function is continuous and smooth.

$\mathcal{DENISE}$: An equation in which some constants are multiplied by variables which are sometimes raised to powers. These are then added and subtracted.

examples provided by S. Z. Keith, "Writing for Educational Objectives in a Calculus Course", *Using Writing to Teach Mathematics*, ed. by A. Sterrett (MAA Notes No. 16), Mathematical Association of America, 1990, pp. 6–10.