Course Syllabus – CE 4121
Computer Applications in Civil Engineering II

Class: M - W 1:00pm - 2:15pm CivE 205

Instructor

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I received a Bachelor's degree in Civil Engineering from the University of Washington in 1978, an Master of Science degree in Mining Engineering from the Colorado School of Mines in 1982, and a Ph.D. in Mining Engineering in 1985 from the same school.

My professional research and consulting has included computer modeling and applied statistics in civil, geological, and mining engineering. I have consulted with 27 different national and international companies, and ten state and federal government agencies. I have taught a university computer applications courses, at all levels, 32 times, and professional short courses 13 times. I am the co-designer and co-author of three successful commercial computer packages currently on the market.

Office hours

Barring an emergency, or sickness, and sometimes meetings, I will be available during my regularly scheduled office hours.

Unlike many of your previous courses, my office hours are "part of the class". I fully anticipate (and look forward to) seeing most of you during my office sometime in the next few weeks. Really, use the office hours.

I will regularly be in one of the two computer labs during office hours. It is usually far more effective if I your answer questions while we are at the computer looking at your code. If my office door is closed during office hours, it usually means that I am in the computer lab – come and find me.

I am also teaching CE 3102 this semester. I will have nominally separate office hours for that class. Nonetheless, my plan is to take students from both classes at both sets of office hours. The scheduled time right after class would be best if you can make it then, but you will not be turned away at other times.

Course prerequisites

The specific prerequisite for this course are as follow:

- CE 3101 Computer Applications in Civil Engineering I,
- MATH 2243 Linear Algebra and Differential Equations,

- MATH 2263 Multivariable Calculus ,
- CE or GeoE upper division, or instructor approval

Yes, we will be writing complex computer programs in this class.

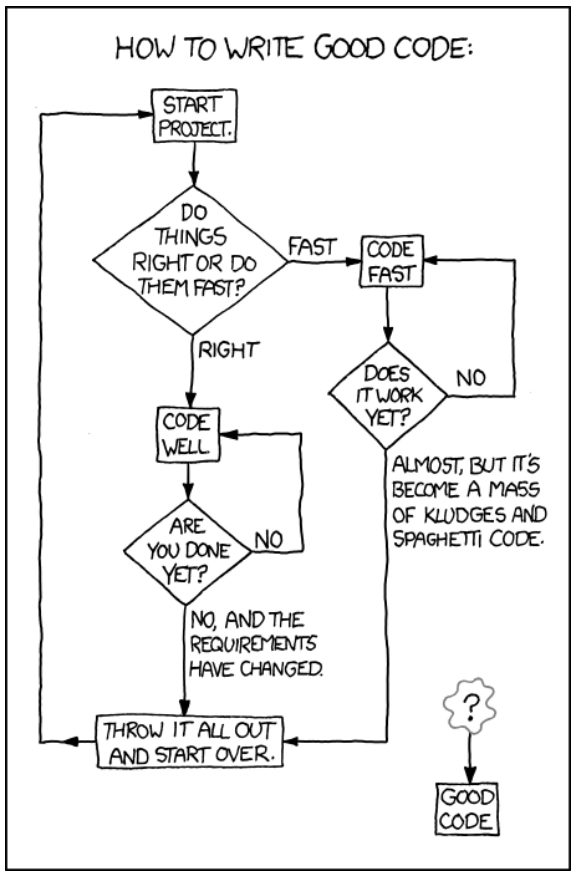
While the concepts, tools, and techniques explored in this course will be taught within the context of advanced Civil Engineering, there are no advanced Civil Engineering prerequisites. You will be learning engineering applications throughout the term since many of the problems that you are going to tackle are taken from 4000, 5000, and 8000-level courses, and some directly from professional practice, in civil and geological engineering.

Programming Prerequisites

You will be required to use computers extensively in this course. Specifically, you will be programming in `MATLAB`.

> This course is designed around the use of `MATLAB`. Although the concepts, algorithms, and models developed in this class transcend the specific programming language, we will use `MATLAB` though out this course.

This course is designed for students who have successfully completed *CE 3101 Computer Applications in Civil Engineering I.*



`http://imgs.xkcd.com/comics/good_code.png`

Required Hardware

If you do not own a *USB flash drive*, go out an buy one. They are available at the University bookstore, and online. Two to four gigabytes will be more than sufficient for this class. You must have a flash drive.

Required Software

All of the necessary software packages for this class are installed on the computers in all CSE Computer Labs (e.g., CivE 230, Walter Library 103, EE/CSci 3-170, etc.) and in the Civil Engineering Computer Lab (CivE 221). You do not need to purchase any software for this class. Furthermore, if you have a computer of your own you can acquire all of the necessary software packages for this class for free or for a small fee.

The most recent version of *MATLAB* is **REQUIRED** for the class.

If you have a computer you can, and should, install *MATLAB*. As undergraduate students in the College of Science and Engineering at the University of Minnesota[1], you can get this powerful tools for free through the University. Go to:

- `http://cselabs.umn.edu/software`
- `https://wwws.cs.umn.edu/matlab/student/`

In addition to *MATLAB*, you will also need the following software tools.

- You must have a web browser. See, for example, `http://en.wikipedia.org/wiki/Web_browser`.

  FireFox, *Chrome*, *Safari*, or *Internet Explorer* are all acceptable. I prefer *Chrome*, but *Moodle* is optimized for *FireFox*, so I use them both regularly.

- You must have a *pdf* viewer. See, for example, `http://en.wikipedia.org/wiki/List_of_PDF_software`.

  The most common *pdf* viewer is probably *Adobe Reader* (`http://get.adobe.com/reader/`), which is free . There are alternatives: *FoxIt Reader* (`http://www.foxitsoftware.com/Secure_PDF_Reader/`) and *SumatraPDF* (`http://blog.kowalczyk.info/software/sumatrapdf/free-pdf-reader.html`) are also free and lighter weight.

- You must have an ASCII text editor. See, for example, `http://en.wikipedia.org/wiki/Text_editor`, or `http://en.wikipedia.org/wiki/Comparison_of_text_editors`. The Windows built-in text editor, `Notepad`, is marginally adequate for this class, but will be a painful experience. I recommend the following alternatives.

  - If you are using a Windows operating system get the text editor *NotePad++*. This is a free, open source, program. Even though it is free, it is better than all of the competing commercial products. Get and install *NotePad++* from

[1] If you are taking this class, but not in CSE, you may still get access to this software. You will, however, need to go and speak with the folks in OIT Technical Support (e.g. `http://www.oit.umn.edu/utools/technical-support/index.htm`.)

    * `http://notepad-plus-plus.org/`

  and quit using the built-in `Notepad`.

- If you are using an Apple OSX operating system get the text editor *TextWrangler*. This is a free, but not open source, program. Get and install *TextWrangler* from

  * `http://www.barebones.com/products/`

Note that Microsoft *Word*, and other similar word processing programs, are **NOT** appropriate tools for text editing. Word processing program embed various hidden formatting descriptors, which typical statistical and data processing packages can not handle.

- You must have a file compression tool/archiver – i.e. a zipper. See, for example, `http://en.wikipedia.org/wiki/Comparison_of_file_archivers`.

  You must know how to use your chosen file compression tool. We must be able to unzip files that you compress/archive. The Windows built-in file compression utility is fully adequate. You may find other packages more convenient: e.g. *WinZip*, or *7-Zip*.

Text Book

All of the "textbooks" for the class are all available online for free. There are **NO** required textbooks to be purchased for this course.

Course Web Page

The course web site will be used for messages and announcements, transferring data and programs, assignments, forums, questionnaires, and to browse your currents grades and standing in the course. The course web site is available through the University of Minnesota *Moodle* server. If you are unfamiliar with *Moodle* you may want to run through the University of Minnesota's "Moodel orientation" at

- `https://umconnect.umn.edu/moodleorientation`

To access the course web site go to `Moodle.umn.edu`, login, and go to the CE4121 site. Make it a habit to look-over this site at least a few times every week. You are **RESPONSIBLE** for staying current with the contents of this site.

Internet and *Wikipedia*

Get in the habit of looking things up online. Often a simple keyword search on Google or Yahoo (or the like) will yield gold. Solutions to some of the theoretical problems that I will assign can be found completed online (no, I am not going to tell you which). When you ask me questions, I will consistently respond by asking if you have looked it up online.

Also, despite some bad press from elsewhere at this University, *Wikipedia* is you friend. I have found the explanation and discussion on concepts, vocabulary, and problem solving within the realm of computer programming, applied mathematics, engineering algorithms,

and MATLAB to be absolutely fabulous on *Wikipedia*. For example, the entries on probability and statistics in *Wikipedia* are superior to almost any classical textbook. Use *Wikipedia*, and the links that simple internet searches offer.

http://imgs.xkcd.com/comics/misconceptions.png

As an aside, if you find useful explanations, formulae, or even work problems on the internet, make **certain** that you include a clear citation in your work. That way you can go back to the site in the future when you need to be reminded about the details. Furthermore, if you find useful links on the internet, make certain to share[2] them with the rest of the class via the appropriate forum on the course Moodle site.

Minimum Requirements

The follow list presents the minimum requirements for passing this course:

- Attend all classes (missed classes should be pre-approved). If you find yourself sick on the morning of class, a simple email will suffice as notification.
- Read all assigned material by the assigned time[3].

[2]Students helping students is a fundamental component in the design of this course. The material in this course is hard, but the resources are vast. By helping each other, you will reap tangible, valuable, benefits.

[3]Much of the reading in this class is going to be quite technical. When you read technical material you must plan on reading it **at least** three times. On the first go, read through the material quickly trying to get the big picture. On the second pass, read with great care, looking up unfamiliar words and notation, and working through the examples. The third pass is quicker: make certain that the various concepts are in order in your mind. This third pass is a good time to haul out the highlighter pen and mark the key concepts, formulae, and passages for future reference.

- Actively participate in class discussions[4].
- Aggressively participate in all group efforts[5]
- Submit all assignments on time and at an acceptable level of quality.
- Carefully complete all of the course evaluations and questionnaires[6]

By-the-by, email is an effective way to communicate with the instructor when you must miss a class.

Grading

Grading is absolute, that is, students are judged on the basis of their demonstrated understanding of the subject matter as well as their ability to solve problems, rather than on their performance relative to other students. I would be thrilled if everyone in this course earned an A or B. This is an outcome that I am personally hoping for.

> The overall course grade will be made up of formal weekly homework assignments, projects, peer review efforts, and ad hoc problems (which will be assigned on the fly). There will be **NO** quizzes or exams.

The cutoffs for the assignment of final grades will be left somewhat fuzzy at this time; however, a 90%/80%/70%/60% can be used as an approximate grading scheme. In fact, if you get more than 90% of the total points, you will receive at least an A- (the "A- cutoff" may be lower, but it will NOT be higher). Similarly, if you get more than 80% of the total points, you will receive at least a B-, etc.

Be forewarned: Anyone earning less than 60% of the points available will **fail** this course.

Homework

Homework problems (projects) will be assigned almost every week. Typically, homework will be assigned on a Wednesday, and will be due the following Wednesday. My expectation is that you will spend sufficient time between the Wednesday and Monday classes to make significant progress on the problems. That way you can ask meaningful questions during

[4]On many occasions you will be given problems with insufficient information. Part of the solution process will be for you to recognize that you need additional information, identify what you are missing, and then ask for it. We will spend time as needed in lectures to address questions. However, the appropriate forum on the course Moodle will be an important resource – post your question and a fellow student or I will answer it quickly. Take this very seriously.

[5]Some homework assignments will involve group efforts. More importantly, I strongly recommend that you create study/homework groups that persist through individual assignments, as well. Historically, there is a strong positive correlation between those who regularly work in study groups and the final grades in this class.

[6]In an effort to improve the course, while you are still in it, there will be a number of questionnaires. Please take the time to respond with thought. These various evaluations are a **REQUIRED** component of this course.

class on Monday. If you postpone all effort on the homework assignments until Tuesday evening, you will regret it.

Most homework assignments and projects will be *individual assignments*. Some homework assignments will be accomplished in a two person group format[7].

On both individual and group assignments, working together on homework is **ALWAYS** allowed and highly recommended[8]: yes, even when you have to hand in individual assignments. However, you must NOT simply partition the effort, for every individual is responsible for all details.

> Unlike most courses that you have taken in the past, this course is designed around students helping students to solve very difficult problems. In this course, I am attempting to emulate professional engineering practice.

Homework Report Format

Technical competence, numerical accuracy, neatness, organization, and clarity of presentation will all be considered in evaluating your work. Unlike CE 3101, the homework assignments will **not** require a lengthy, formal report. Typically, only a one page letter report will be required. Also, **ALL** homework will be submitted electronically[9].

Nonetheless, basic standards apply to your submitted work. For example,

- ALL numerical answers **must**[10] have units associated with them. If numbers are dimensionless, this must be explicitly denoted.
- ALL graphs **must** have a title, labeled axes (including units), and a legend (when appropriate).
- ALL tables **must** have a title, and labeled columns (including units).

If I can not follow your work, I will NOT give you partial credit. Furthermore, a correct final answer is NOT sufficient for full credit. In short, treat your homework assignments as a small professional project.

Time and Effort

As you will all be required to do in professional practice, in this course you will be responsible for detailed time tracking. On every assignment you **must** keep detailed track of your time on task. Your time should be recorded to the nearest 15 minutes (1/4 hour).

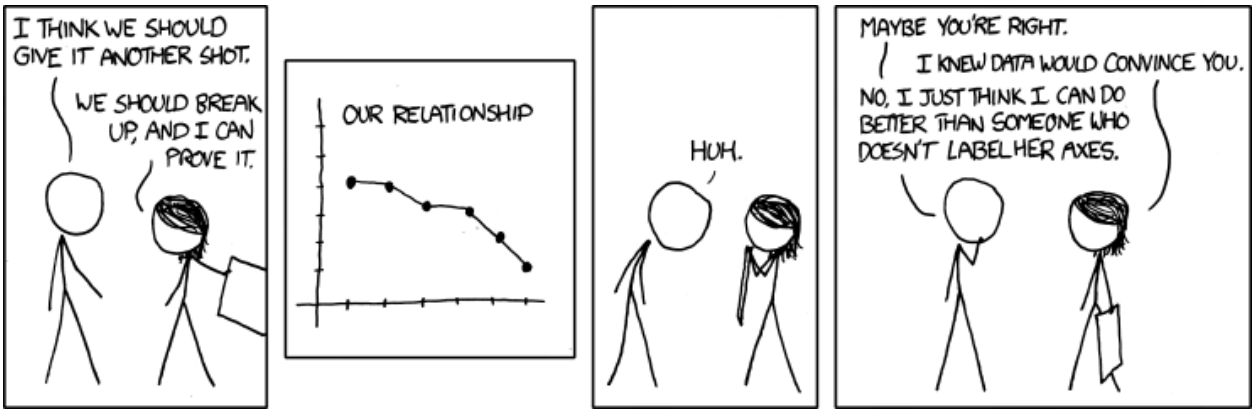
At a minimum, the following line items must be broken out in your time record.

[7] See `http://en.wikipedia.org/wiki/Pair_programming`

[8] As such, it is in your best interest to immediately initialize and develop professional relationships with students in the class. For example, study groups that meet regularly in the CivE building, and active participation on the forums found on the course Moodle site, would both be worthwhile ventures. If you are shy and do not know others in the class, it is your responsibility to work on this personal weakness. If you are gregarious, it is your responsibility to meet others and get them involved – especially the shy folks.

[9] I would like this class to be almost paperless.

[10] This is an engineering class! Take this very seriously. Numbers without units are wrong.



http://imgs.xkcd.com/comics/convincing.png

- Project reading and research.
- Project meetings.
- Program design.
- Programming.
- Program testing and debugging.
- Program execution and generation of final results.

If a particular specific issue, or bug, takes an inordinate amount of time you should record this difficulty.

Note: your grade is not determined by the total time spent (or the total group time spent). Some people take longer to complete a task, while some people are quite speedy. You will be graded on quality. The best engineer is not the individual who gets an answer the fastest, nor is the best engineer the person who spends the most time on a problem; rather, the best engineer is the person who finds proper answers most often.

You will be required to submit an invoice for each project based upon this record of time and task reporting.

Quizzes

None.

Midterm Exam

None.

Final Exam

None.

Peer Review

Throughout the semester you may be required to participate in peer review exercises. Your efforts in this context will count towards your grade.

Expectations

The basic assumption of this course is that learning results from a continuing process of rational discourse. Within the course there are both opportunities and responsibilities. In this course you have the opportunity to learn. Your responsibilities are to maximize your learning from the course (i.e., improve your intellectual understanding), maximize and assist in the learning of your classmates, and to apply what you learn to your work. To take advantage of the opportunity and to meet your responsibilities you are to:

- Master the basic concepts, theories, methods, and heuristics. You are expected to know a great deal more after taking this course than you did before.
- Explain precisely to several classmates what you have learned; this includes specific details, insights and conclusions. Your learning is not complete until you teach what you know to someone else and can describe precisely what you have learned and what you understand[11].
- Ask others to share their knowledge, conclusions, and insights with you. When they do so, listen carefully, elaborate by explaining how what you learned from them fits in with previous knowledge you have learned, or question them if their explanation contradicts your understanding, and then thank them.
- Engage in intellectual controversy by taking positions counter to those of your classmates, developing clear rationales for your positions, challenging their reasoning and conclusions, and arguing the issues until you or they are all logically persuaded.

The time and effort required in this class will be significant. It is expected that students working toward an A or B grade in this course(which I hope is true for everyone) will spend, on average, between 8 and 12 hours per week on this course[12]. Take this seriously. If you know that you can not devote this amount of focused-time to this course, I strongly recommend that you consider dropping the course.

Tentative Outline

The following is a tentative outline for the 15 weeks. Reality will significantly deviate from this outline, almost surely.

[11]This may sound a bit silly, and far too *touchy-feelly* for most engineers. But, hardcore research has shown it to be an incredibly powerful technique for learning, for identifying gaps in your understanding, and for enhancing the retention of what you have learned. Try it.

[12]The formal university policy is 9 hours per week, on average, for an average student striving for an average grade in a three credit course. See `http://www1.umn.edu/usenate/policies/gradingpolicy.html`, including class time. Historically, the average grade in this class is a B.

Week 1 Spatial interpolation of irregularly spaced data over irregular polygons (e.g. interpolating rainfall data over a watershed). Multiquadritic interpolation. Bilinear interpolation. Solving large systems of linear equations.

Week 2 Shortest route problem and dynamic programming (e.g. for on-board navigation with intelligent vehicle systems). Dijkstra's shortest route algorithm. Graph models and data structures.

Week 3 Constrained least squares (e.g. adjustment of traffic network surveys). Network-based models and data structures: node-arc incidence matrices.

Week 4 Computer computations, understanding IEEE 754-2008 floating point numbers. Dealing with truncation and round-off by choosing wisely, and a bit of math. Series expansions, Horner's rule, computational efficiency (e.g. stress singularities).

Week 5 Computational geometry, numerical integration over irregular shapes (e.g. average rainfall over a watershed). Point-in-polygon algorithms.

Week 6 Linear optimization (e.g. mixing and blending).

Week 7 Nonlinear optimization (e.g. model selection using genetic algorithms).

Week 8 Nonlinear systems of equations (e.g. large pipe networks).

Week 9 Monte Carlo simulation and queueing theory (e.g. ramp monitoring).

Week 10 Deterministic simulation using mechanics (e.g. distinct element modeling).

Week 11 Solving systems of ordinary differential equations.

Week 12 Solving partial differential equations, finite difference formulations (e.g. the heat equation for modeling thermal stress in pavements).

Week 13 Large-scale, complex system optimization (e.g. optimizing a truss).

Week 14 Stochastic simulation of complex systems (e.g. cell dynamics).

This is merely a plan. As I am attempting to increase the scope of this course this time around, this is a somewhat new curriculum. This plan is guaranteed to change over the semester: some projects, not listed above, will be added and other projects will be dropped.

Some specific concepts from computer science include:

- Anti-bugging programming techniques
- Debugging techniques
- Unit testing and components of "agile programming"
- Pair programming
- Computer arithmetic
- Classic model structures
- Lists, networks, and associated data structures

Academic Standards

Students are responsible for knowledge of and adherence to the published academic code of conduct. This can be found on the internet at:

`http://www1.umn.edu/regents/policies/academic/Student_Conduct_Code.html`

The University Student Conduct Code defines scholastic dishonesty as follows:

> Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis.

Within this course, a student responsible for scholastic dishonesty can be assigned a penalty up to and including an "F" or "N" for the course. If you have any questions regarding the expectations for a specific assignment or exam, ask.