CE 597: Computational Methods in Civil Engineering

Lyles School of Civil Engineering, Purdue University

CE 597 Computational Methods in Civil Engineering (Fall 2016)

Instructor: Pablo Zavattieri

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Tuesday/Thursday 9:30-10:15am in HAMP 1252

Office Hours: Tuesday 10:30-11:30am, whenever I am in my office or by appointment

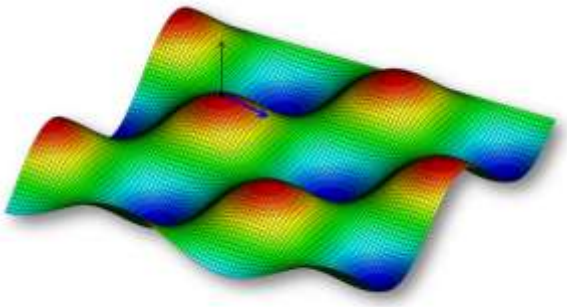
Course Description: The objective of the course is to introduce students to numerical methods for solving problems in civil engineering (both for modeling and experimental work). The course provides students with the necessary background to enable them to use basic computational tools and gain a fundamental understanding of numerical methods. It also introduces them to basic computer programming and inculcates a systematic logical thought process towards problem solving. This course is aimed to graduate students.

Pre-requisites: linear algebra, index and matrix notation. In particular the student should be comfortable with matrix and index notation.

Course Objectives:

- Introduce the student to the classical numerical methods available for engineering problem-solving
- Familiarize the student with the computer as an engineering tool and to improve programming skills
- Emphasize fundamental understanding of the methods based on concepts previously acquired in algebra
- Importance of errors associated with scientific computing and the interpretation of results

List of topics: Introduction to scientific computing (basics, loops, if statements, machine precision, double precision, etc). Introduction to Linux/Unix environment, Tutorial on C and Fortran, Systems of linear equations, Solution to non-linear equations, Interpolation and polynomial approximation, Optimization, Numerical differentiation, Numerical integration, Partial differential equations, Ordinary differential equations.



Books: No book is required. I will personally follow ideas from the following books and resources:

1. *Scientific Computing. An Introductory Survey*, Michael T. Heath, McGraw Hill, 2nd edition
2. *Numerical Methods for Engineers*, Steven C. Chapra, Raymond, P. Canale, 7th Edition, McGraw Hill, 2015.

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Schedule: This is a tentative schedule and it is intended to be a guide. Students are expected to anticipate the topics that will be covered in class by attending the classes and following this guide**.** Any type of change to this schedule will be announced at the beginning of the class. The syllabus (and this schedule) will be kept updated on Blackboard.

Week 1	day 1	Course Introduction
	day 2	Introduction to Unix/Linux environment, and C (basic commands)
Week 2	day 3	Introduction to C (pointers and arrays), Fortran
	day 4	Introduction to Engineering Computing, Approximation, Source of errors
Week 3	day 5	Systems of Linear Equations, Matrix Notation, Direct Methods
	day 6	Direct Methods, Gaussian Elimination
Week 4	day 7	Gaussian Elimination and Examples
	day 8	Gauss-Jordan elimination and LU decomposition, examples
Week 5	day 9	Discussion on Pivoting, Matrix Condition, banded and sparse matrices
	day 10	Class/Lab Activity, examples and programming
Week 6	day 11	Iterative Methods, Jacobi, Gauss-Seidel, Successive over relaxation
	day 12	Conjugate gradient method, Examples
Week 7	day 13	Class/Lab Activity, examples and programming
	day 14	Nonlinear Equations, Existence, uniqueness, convergence rates, basic methods (interval bisection, fixed point, secant method)
Week 8	day 15	Newton method, examples
	day 16	Class/Lab Activity, examples and programming
Week 9	day 17	Interpolation, Lagrange, Newton, Orthogonal, Piecewise, Cubic Spline, B-splines
	day 18	Optimization
Week 10	day 21	System of Nonlinear Equations, fixed point, secand method, examples
	day 22	Newton Rapson Method, Broyden Methods, comparison and examples
Week 11	day 23	Class/Lab Activity, examples and programming
	day 24	Numerical differentiation, forward, central and backward differentiation
Week 12	day 25	ODE (Ordinary Differential Equations), stability and errors, Euler's method, Implicit Trapezoid Method
	day 26	ODE, Taylor Series Method, Runge-Kutta
Week 13	day 27	PDE (Partial Differential Equations), Classification of PDE, Finite differences
	day 28	PDE: Semi discrete methods, fully discrete methods, implicit methods, Crank-Nicolson
Week 14	day 29	Integration, Numerical, Newton-Cotes and Gaussian quadrature
	day 30	Integration, Area/Volume integral, error and adaptive quadrature
Week 15	day 31	Class/Lab Activity, examples and programming
	day 32	Summary and review

Academic Integrity:

Academic integrity is expected of all students at all times. Information on what constitutes academic integrity may be found in the handbook University Regulations. Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Information on what constitutes academic integrity may be found in the Purdue's student guide for academic integrity (http://www.purdue.edu/odos/academic-integrity/)

Use of Copyrighted Materials

Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Violent Behavior Policy

Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See the following website for additional information: http://www.purdue.edu/policies/

Students with Disabilities

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University. If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the

first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications.

Nondiscrimination

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously. Prof. Zavattieri is Safe Zone trained

Emergency Procedures:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Information will be provided via email and/or Blackboard. If a student suspects he or she may have symptoms associated with the swine flu, you are encouraged to seek medical help and not come to class. Please see Purdue's Emergency Preparedness website at http://www.purdue.edu/emergency_preparedness/index.html, and the Adverse Winter Weather Procedures and Announcements.

Emergency exist plans have been prepared for all classrooms located in engineering buildings. The following link provides critical information Evacuation and Shelter-in-place for our main classroom HAMP 1252: https://engineering.purdue.edu/CE/Safety/HAMP-BEP-04-2015.pdf

Here are ways to get information about changes in this course:

- Course Web Site: https://engineering.purdue.edu/~zavattie/NumericalMethods/
- Instructors' contact information: Prof. Pablo Zavattieri, (765) 496-9644, zavattie@purdue.edu

Others

No food and absolutely no cell phones in the classroom or lab.