CE 597: Computational Methods in Civil Engineering (Fall 2018)
Instructor: Pablo Zavattieri (zavattie@purdue.edu)
Monday/Wednesday/Friday 9:30-10:20 am in HAMP 2118
Office Hours: TBD, 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.

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

Course Objectives:
• Introduce students to classical numerical methods available for engineering problem-solving
• Expose students to concepts such as precision, errors and tolerances and their effect on the quality of the solutions produced by scientific computing
• Develop and practice systematic, logical thought processes towards problem solving
• Introduce students to a computer language for scientific computing
• Improve programming skills and familiarize students with the computer as an engineering and simulation tool
• Enhance fundamental understanding of concepts acquired in algebra, calculus and differential equations


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

| Week 1 | Course Introduction  
Review, Programming and some Matlab |
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| Week 2 | Introduction to Engineering Computing, Approximation, Source of errors  
Systems of Linear Equations, Matrix Notation, Direct Methods |
| Week 3 | Direct Methods, Gaussian Elimination  
Gaussian Elimination and Examples |
| Week 4 | Gauss-Jordan elimination and LU decomposition, examples  
Discussion on Pivoting, Matrix Condition, banded and sparse matrices |
| Week 5 | Iterative Methods, Jacobi, Gauss-Seidel, Successive over relaxation |
| Week 6 | Conjugate gradient method, Examples |
| Week 7 | Nonlinear Equations, Existence, uniqueness, convergence rates, basic methods  
(interval bisection, fixed point, secant method)  
Newton method, examples |
| Week 8 | Class/Lab Activity, examples and programming  
Interpolation, Lagrange, Newton, Orthogonal, Piecewise, Cubic Spline, B-splines |
| Week 9 | Optimization  
System of Nonlinear Equations, fixed point, secant method, examples |
| Week 10 | Newton Rapson Method, Broyden Methods, comparison and examples  
Class/Lab Activity, examples and programming |
| Week 11 | Numerical differentiation, forward, central and backward differentiation  
ODE (Ordinary Differential Equations), stability and errors, Euler’s method, Implicit Trapezoid Method |
| Week 12 | ODE, Taylor Series Method, Runge-Kutta  
PDE (Partial Differential Equations), Classification of PDE, Finite differences |
| Week 13 | PDE: Semi discrete methods, fully discrete methods, implicit methods, Crank-Nicolson  
Integration, Numerical, Newton-Cotes and Gaussian quadrature |
| Week 14 | Integration, Area/Volume integral, error and adaptive quadrature  
Class/Lab Activity, examples and programming |
| Week 15 | Project Presentations |
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 (https://www.purdue.edu/odos/osrr/academic-integrity/index.html)

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.

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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.

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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 https://www.purdue.edu/ehps/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