Fall 2010

# CEG 416-01: Matrix Computations

Ronald F. Taylor
*Wright State University - Main Campus*, ronald.taylor@wright.edu

# CEG/MTH 416/616 Matrix Computations

Fall 2010 Tu Th 12:20 – 1:35 p.m. Russ Center Room 153
Last Updated: August 27, 2010

**Description:** This course is a survey of numerical methods in linear algebra for application to problems in engineering and the sciences. Emphasis is on using modern software tools on high performance computing systems. This course covers the mathematics of linear equations, eigenvalue problems, singular value decomposition, and least squares. Material covered will be relevant to applications areas such as structural analysis, heat transfer, neural networks, mechanical vibrations, and image processing in biomedical engineering. A familiarity with MATLAB is useful, and the ability to program in languages such as C/C++ or Fortran is very important. A basic knowledge of matrix algebra is required. Four credit hours.

**Prerequisites:** MTH 253 or 355 (matrix or linear algebra); and CS 142 or 241 (intermediate programming).

**Instructor:** Dr. Ronald F. Taylor, RC 340, 775-5122, ronald.taylor@wright.edu, office hours: 3:00 – 4:00 p.m. on Tuesday and Thursday; 10:00a.m. – Noon on Wednesday (other times by appointment).

**Required Textbook:**

Numerical Linear Algebra and Applications, **2nd Edition**, Biswa Datta, SIAM, 2010, ISBN 978-0-898716-85-6.

**Suggested Resources:**

Matrix Operations, Richard Bronson, Schaum's Outline, McGraw-Hill, 1998, ISBN 0-07-007978-1. (E-book Dunbar Library)

**Course on WebCT:** We will be using WebCT for posting of content, grades and submittal of some assignments or portions of assignments. Students should familiarize themselves with accessing WebCT: http://wisdom.wright.edu/. Students are also responsible for printing copies of resource materials from WebCT as needed. Some handouts may be given in class.

**Programming:** MATLAB Student Edition http://www.mathworks.com/academia/student_version/ from MathWorks (about $100). Also Dev-C++ Version 4.9.9.2 for Windows http://www.bloodshed.net (free download – use C compiler). Writing and using numerical programs is an important part of this course. Programming assignments mostly will require MATLAB which is available on a number of Wright State systems. Many times numerical work can be done on a scientific or programmable calculator. MATLAB is very useful, and you may want to consider purchasing the Student Edition if you have a PC that can support it. It is expected that students will spend a minimum of 2 hours per week working in a computer lab or equivalent environment enhancing their programming skills and completing programming assignments for this course. We will also use the C programming language for some class demonstrations. Some assignments may involve using or adapting some given C programs. Both MATLAB and C will be covered in lecture. The emphasis will be on MATLAB, however.

**Use of E-Mail:** All registered students have access to a Wright State e-mail account. The Instructor will use only that e-mail account to initiate communication with student. The Instructor will reply to other e-mail accounts. IMPORTANT: Please include in any communication with Instructor, a Subject which starts with "CEG 416" (or CEG 616, MTH416, MTH616). For example, a student with a question about HW 1, would use as a Subject: "CEG416: Question on HW 1 Problem 2."

**Grading Policy:** Mid-term exam and quizzes – 35% . One comprehensive final – 40%. Homework/Project assignments – 25%. Quizzes may be in class, take-home, or in-office Q&A: points included with mid-term score. If more than four quizzes are given, the one with the lowest percentage grade will be dropped. Quiz point values may vary. Students registered at the graduate level (i.e. CS 516 or MTH 516) will be required to complete extra problems, programs and/or special projects as part of the Homework/Project component of this course. Expect about six major Homework/Project assignments. A number of problems assigned may be considered "practice" and will not be graded. In general, one week will be given to prepare these assignments. Smaller homework problems/investigations may be due the next class period. Follow the "Homework Standards" posted on the course website. IMPORTANT: Submit any specified program files to be graded via WebCT only -- materials sent by e-mail will not be graded. Course Grade Based on Average:

**A:** 100-90, **B**: less than 90-80, **C:** less than 80-70, **D:** less than 70-60, **F:** less than 60-0.

**Class Policies:** No late or early exams unless verifiable emergency. No make-up quizzes: quizzes may be unannounced. Attendance at lecture is not a component of your grade. However, students are expected to attend all lectures and to participate in class discussion. Attendance may be taken in the course to better get to know students. In cases of infrequent attendance, lower homework and exam grades will inevitably result since a significant portion of lecture material is not covered in the text. All Homework/Project assignments are due at the start of class and/or in WebCT on the date and time specified. Grades on late assignments will be reduced by 10%. Submittals more than one day late will not be graded - "zero" grade assigned. Exceptions to the above policies may be made unusual circumstances when documentation is provided in writing -- otherwise expect strict enforcement of the policies. All work submitted must be your own unless group assignments are explicitly made by the Instructor; sharing of program code or copying problem solutions/codes from any source will result in at least a homework grade of "zero" for all involved and possibly a grade of "F" for the course. University procedures for plagiarism will be strictly followed. Sharing ideas and general mathematical and computer skills with others outside of class is encouraged. Students are expected to read, understand and follow the University Academic Integrity Policy at:

http://www.wright.edu/students/judicial/integrity.html

**Supplemental Class Information and Homework Standards:** A document: "Supplemental Information" is given on WebCT which clarifies and details how the above class and grading policies are to be implemented. Also carefully study and follow the "Homework Standards" document also on WebCT. Students are responsible for understanding these documents referring to them during the quarter as needed. Please ask for clarification if you have questions about either document.

**Schedule:** Topics may vary. **Exams dates and times** are firm. "Chapter" is the Required Textbook "Class Notes" are from

| Week | Topic/Tests etc. | Readings/Reference |
|---|---|---|
| 1 | Introduction to Matrix Computations;<br>Matrix Operations and Applications;<br>MATLAB Fundamentals | Chapter 1 and Notes |
| 2 | Matrix Concepts: Vectors, Orthongonality, Special Matrices, Norms, Introduction to the Singular Value Decompostion and Eigenvalue Problems | Chapters 2 |
| 3 | Floating Point Numers and Computational Errors<br>Introduction to Stability & Condition | Chapters 3 and 4 (or equivalent Notes) |
| 4 | Solving Linear Equations by Gaussian Elimination & Factorization | Chapter 5 and Notes |
| 5 | Solving Linear Equations by Iteration and Applications<br>**Mid-Term Exam: Th October 7, 2010 (full period).** | Chapter 12 and Notes |
| 6 | QR Factorization and the Singular Value Decomposition | Chapter 7 and Notes |
| 7 | Least Squares Solutions of Linear Equations and Applications | Chapter 8 and Notes |
| 8 | Matrix Eigenvalue Problems and Applications | Chapters 9, 10 and Notes |
| 9 | Generalized Eigenvalue Problem and Applications | Chapter 11 and Notes |
| 10 | Selected Special Topics & Applications (as time permits): Image Processing, Data Mining & Parallel Computations | Notes |
| **Finals** | **Comprehensive Final: Tu November 16, 2010, 1:00 – 3:00 p.m.** | |