

**ENGR 3703 Computational Methods of Engineering**

Fall 2006

Department of Physics and Engineering  
University of Central Oklahoma

<b>Location</b>	Howell Hall 100
<b>Time</b>	MWF 12:00 - 12:50 p.m.
<b>Instructor</b>	Evan Lemley, Ph.D.; Assoc. Prof. of Physics and Engineering
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<b>Office Hours</b>	MWF 10:00 a.m. - 11:00 a.m. or by appointment.
<b>Final</b>	W December 13, 2006 from 11:00 a.m. - 12:50 p.m.

**Course Description**

This course introduces general-purpose numerical methods and linear algebra concepts for solving problems in science and engineering. Students should develop an understanding of the strengths and limitations of standard numerical techniques applied to problems in engineering, such roots of nonlinear equations and systems of linear equations. The course will also cover numerical differentiation and integration, initial-value and boundary-value problems. The course will also discuss concepts and methods of scientific and engineering computing, mathematical modeling, and engineering design.

**Prerequisites**

- ENGR 1213, PHY 2014, and MATH 3103 or concurrent enrollment.
- Knowledge of the C programming language, Excel, and MATLAB.

**Programming Notes**

- When submitting C programs students should ensure they are in ANSI Standard C. I will use the gcc compiler to test programs. The compiler is available via the web at: <http://gcc.gnu.org/>. Note in Windows you will need to get Cygwin which contains the gcc compiler. Cygwin is available at: <http://www.cygwin.com/>.

**Textbooks**

*Numerical Methods for Engineers*, 5/E, Steven C. Chapra and Raymond P. Canale, ISBN: 0-07-310156-7, McGraw-Hill, 2006.

**Objectives**

The student will be able to

- Demonstrate understanding of basic programming skills, and algorithms.
- Demonstrate understanding of the engineering software design process.
- Demonstrate understanding of significant figures, accuracy, precision, and error.
- Demonstrate understanding of bracketing and open root-finding techniques.
- Demonstrate understanding of numerical solution of linear and non-linear algebraic equations.
- Demonstrate understanding of least-squares curve-fitting techniques and interpolation schemes.
- Demonstrate understanding of numerical differentiation.
- Demonstrate understanding of numerical integration.
- Demonstrate understanding of Euler's methods and improvements on Euler's methods for solution of ordinary differential equations.

- Demonstrate understanding of the Runge-Kutta methods for solution of ordinary differential equations.
- Participate in a team design project that incorporates computational tools, including report preparation and a project presentation.
- Demonstrate understanding of the use of software to solve engineering problems and the necessity to use factors of safety for protection of the public.
- Demonstrate understanding that computational methods are fast-changing and that continuous education and training will be necessary in this field throughout a career.

### **Calculator**

You must own a scientific calculator – see *the list of allowed calculators for exams in the Department of Physics and Engineering*. **Please bring your calculator to class for each meeting.**

[http://evan.lemley.org/courses/allowed\\_calculators\\_fall\\_2004.pdf](http://evan.lemley.org/courses/allowed_calculators_fall_2004.pdf)

### **Engineering Paper**

Engineering Paper -- available from the UCO bookstore, Thompson's Bookstore, and Triangle A&E at Broadway Ext. and 63rd. Please use engineering paper for all homework assignments.

### **Internet & E-mail**

Access to the Internet and ability to send and receive E-mail. If you do not have a computer at home you can use machines on the UCO campus: Look at

<http://technology.ucok.edu/support/microcomplab.htm>

for a full list of available general use computers on campus.

### **Portable Electronic Devices (including cell phones)**

Please turn off any portable electronic devices (esp. cell phones) during class. You may not access any portable electronic device during exams except calculators that are on the approved list for Physics and Engineering courses.

### **Instruction Techniques**

Lecture will be used predominantly although sometimes recitation periods will be employed.

### **Class Polices**

Attendance is not required, but you will be responsible for any announcements or notes from class (and quizzes).

Attendance is mandatory for all exams or other graded activities (e.g. project competitions or presentations).

Cheating or academic dishonesty of any kind will not be tolerated.

### **Homework**

Working HW problems in a timely manner is the best way to do well on exams and in the class as a whole. Homework is due at the beginning of the class period on the due-date or due-day. Homework should be neatly written on only one side of your paper, folded length-wise with your name written on the outside of the folded pages before turning it in. Each problem should fit all of the following criteria: clearly labeled, **one problem per sheet of paper**, legible and organized. HW papers that do not fit these criteria will be penalized accordingly. See the attached HW Format section for details on the presentation of HW problems. You may also visit the following site for an electronic version of the homework format requirements:

[http://evan.lemley.org/courses/hwk\\_format.php](http://evan.lemley.org/courses/hwk_format.php)

Each HW problem you turn in is worth ten points. Some problems will be graded on detailed solutions and others will be graded on effort. I will **not** tell you ahead of time which or how many problems will be graded relative to a detailed solution, but on the returned and graded HW paper a check mark next to the problem number will indicate full effort (or ten points) and a numerical score (e.g. 8/10) next to the

problem number will be used on those problems under more scrutiny.

**Project**

There will be Team Design Projects in this course. Projects will constitute a significant portion of your grade. More information will be given to you as project assignments are made.

### **Grading Policies**

The following table shows the breakdown of credit for the course.

HW and Misc.	10%
Exams (x3)	10%
Projects	30%
Final Exam	30%
<b>Total</b>	<b>100%</b>

### **Tentative Grading Scale**

90-100% -- A, 80-90% -- B, 70-80% -- C, 60-70% -- D, <60% -- F

### **STUDENT INFORMATION SHEET / SYLLABUS ATTACHMENT**

Go to:

<http://www.busn.ucok.edu/academicaffairs/FORMS/Student%20Information%20SheetFal06.pdf>

<b>Tentative ENGR 3703 Computational Methods Schedule</b>					
<b>Week #</b>	<b>Day</b>	<b>Date</b>	<b>Topics and Activities</b>	<b>Text Sections</b>	<b>Covered</b>
1	M	08/21/2006	Syllabus Intro & Programming Review	1.1-1.2	
	W	08/23/2006	Programming Review	2.1 – 2.3	
	F	08/25/2006	Programming Review	2.4-2.6	
2	M	08/28/2006	Sig. Figs., Accuracy and Precision, and Error Defs.	3.1-3.3	
	W	08/30/2006	General Error discussion and round-off error	3.3-3.4	
	F	09/01/2006	Taylor Series and the remainder term & Error Propagation	4.1-4.2	
3	M	09/04/2006	<b>LABOR DAY – NO CLASS</b>		
	W	09/06/2006	Total Error & other error topics	4.3-4.4	
	F	09/08/2006	Graphical Root finding & Bisection	5.1-5.2	
4	M	09/11/2006	False-Position & Incremental Searching	5.3-5.4	
	W	09/13/2006	Fixed-Point Iteration & Newton-Raphson	6.1-6.2	
	F	09/15/2006	Newton-Raphson & Secant Method & other techniques	6.2-6.5	
5	M	09/18/2006	Root-Finding with Software	7.7	
	W	09/20/2006	Gauss Elimination	9.1-9.3	
	F	09/22/2006	<b>EXAM 1</b>		
6	M	09/25/2006	Gauss Elimination & Improvements	9.3-9.4	
	W	09/27/2006	Complex and Non-linear systems	9.5-9.6	
	F	09/29/2006	Gauss-Jordan	9.6-9.7	
7	M	10/02/2006	LU Decomposition	10.1	
	W	10/04/2006	Matrix Inversion	10.2	
	F	10/06/2006	Ill-conditioned systems & Iterative refinement	10.3	
8	M	10/09/2006	Special Matrices	11.1	
	W	10/11/2006	Gauss-Seidel	11.2	
	F	10/13/2006	Using Software to solve linear algebraic equations	11.3	
9	M	10/16/2006	Least-Squares Regression	17.1-17.2	
	W	10/18/2006	Least-Squares Regression	17.3-17.5	
	F	10/20/2006	<b>FALL BREAK – NO CLASS</b>		
10	M	10/23/2006	Newtons and LaGrange Interpolation	18.1-18.2	
	W	10/25/2006	<b>EXAM 2</b>		
	F	10/27/2006	Newtons and LaGrange Interpolation	18.3-18.5	
11	M	10/30/2006	Spline Interpolation	18.6	
	W	11/01/2006	Spline Interpolation	18.6	
	F	11/03/2006	Trapezoidal Rule	21.1	
12	M	11/06/2006	Simpson's Rules	21.2	
	W	11/08/2006	Other Newton-Cotes Integration Considerations	21.3-21.5	
	F	11/10/2006	Romberg Integration	22.1-22.2	
13	M	11/13/2006	Gauss Quadrature	22.3	
	W	11/15/2006	Improper Integrals	22.4	
	F	11/17/2006	Numerical Differentiation	23.1-23.2	
14	M	11/20/2006	Numerical Differentiation	23.3-23.5	
	W	11/22/2006	<b>THANKSGIVING BREAK – NO CLASS</b>		
	F	11/24/2006	<b>THANKSGIVING BREAK – NO CLASS</b>		
15	M	11/27/2006	Euler's Method and Improvements	25.1-25.2	
	W	11/29/2006	Runge-Kutta Methods	25.3	
	F	12/01/2006	<b>EXAM 3</b>		
16	M	12/04/2006	Runge-Kutta Methods	25.4	
	W	12/06/2006	Runge-Kutta Methods	25.5	
	F	12/08/2006	Boundary Value Problems and Eigenvalue Probs.	27.1-27.2	
17	F	12/17/2006	<b>FINAL EXAM -- W December 13, 2006 from 11:00 a.m. - 12:50 p.m.</b>		