CE 303 Numerical Analysis for Civil Engineers
Fall 2017 - 29266

Catalog Description: (3 units) Finding Roots of Nonlinear Equations, Solution Techniques for System of Linear Equations, Curve Fitting – Polynomial and Spline Interpolation, Least Squares Fit, Numerical Differentiation and Integration, Solution of Ordinary Differential Equations - Initial and Boundary Value Problems; Use of MATLAB codes in Numerical Analysis for solving Civil Engineering Problems.

Prerequisite(s): MATH 129, Advanced Standing: Engineering.

Course Objective: To give students necessary background on numerical analysis needed to solve engineering problems numerically when their analytical solution is either not available or difficult to obtain. MATLAB programming environment will be introduced and used in this course.

Instructor:	Cac M. Dao, Ph.D. – Ph.621-2266 (Message only)
Class time & place:	MWF 1:00pm-1:50pm, Electrical and Computer Engineering. Room 102
Office Hours:	MW 2:00pm-3:00pm, Civil Engineering Bldg. Room 324E
E-mail:	cmd@email.arizona.edu

Text Book:

Numerical Methods for Engineers and Scientists: An Introduction with Applications using MATLAB, Amos Gilat and Vish Subramaniam, 3rd Edition. Pub. John Wiley [Most but not all topics are covered in the textbook]

Additional recommended books for students who like supplementary reading

1. *Applied Numerical Analysis - Using MATLAB*, Laurene V. Fausett, Pub. Prentice Hall [Good for computer codes but not so good for explanation].
2. Applied Numerical Methods with MATLAB for Engineers and Scientists, Steven C. Chapra, Pub. McGraw Hill, [Good for explanation but not everything is covered in this book and only a few computer codes are given].

Software

MATLAB – Some online tutorial help is available at the following websites
http://www.mathworks.com/academia/
http://www.mathworks.com/academia/student_center/tutorials/index.html?link=body

However, if you attend the class regularly and follow the lectures then you do not need any outside help. All registered students can use MATLAB for free. You can download the software from the university website. You can run this software as long as you are a student of the University of Arizona. However, if you want to own the software without any expiration date and would like to use it beyond your student years then you can purchase MATLAB student version that costs about $100.

Policy Regarding Absences:

Textbook and recommended other books cannot substitute the class lectures. Attendance will be taken at every class lecture. Students are expected to attend all lectures and to be on time. Except in emergencies, a student must give the instructor advanced, notice <u>in writing</u> for an excused absence. More than three (3) absences are considered to be "excessive" and will be cause for an administrative drop, which carries with it an automatic grade of "E".

ABET outcomes:

Primary
    A. Apply mathematics, science and engineering principles

Secondary
    E. Ability to identify, formulate, and solve engineering problems
    G. Ability to communicate effectively
    I. Recognition of the need for and an ability to engage in life-long learning
    K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
    L. Pass the FE exam as the first step towards professional registration

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Syllabus:

1. Review of the Mathematical Foundation (Chapter 1, 2)
- Physical Meaning of Derivatives and Integrals
- Taylor Series Expansion
- Definition of Matrix and Vector; Matrix Algebra - Summation, Subtraction and Multiplication of Matrices; Transpose, Determinant and Rank of a Matrix

2. Fundamentals of MATLAB programming (Appendix A)

3. Solving System of Linear Equations (Chapter 4)
- Unique and Multiple Solutions, Trivial and Non-Trivial Solutions, No solution
- Direct Methods
    - Gauss Elimination method
    - Gauss Elimination with Row Pivoting
- Iterative Methods
    - Jacobi method
    - Gauss-Seidel method

4. Roots of Nonlinear Equations (Chapter 3)
    - Incremental Search Method

- Bisection Method
- Regula Falsi and Secant Methods
- Newton-Raphson Method or Newton's Method

5. Curve Fitting and Interpolation (Chapter 6)
   - Polynomial Interpolation – Lagrange and Newton's Polynomials
   - Cubic and Quadratic Spline Interpolation
   - Curve Fitting by Function Approximation
   - Least Squares Fit

6. Numerical Differentiation (Chapter 8)
   - Finite Difference Methods – Forward, Backward and Central Difference formulae
   - Derivatives for Noisy Data

7. Numerical Integration (Chapter 9)
   - Euler, Mid-Point, Trapezoidal, Simpson and Gaussian Quadrature schemes.

8. Solution of Ordinary Differential Equations: Initial Value Problems (Chapter 10)
   - Euler's explicit method
   - Modified Euler's method, Midpoint method
   - Runge-Kutta methods (2nd, 3rd and 4th order methods)
   - Modified Euler's Predictor-Corrector method

9. Solution of Ordinary Differential Equations: Boundary-Value Problems (Chapter 11)
   - Shooting method
   - Finite-Difference method

Home Work

Homework problems will be posted on d2l. Homework is to be done neatly using only one side of a sheet. Homework due date and cutoff time will be announced every time a homework is assigned. The homework submitted after the due date will be marked late but will be graded and returned as long as it is submitted before the cutoff time. Homework submitted after the cutoff time will not be graded and a grade of zero will be assigned.

Exams & grading policy:

This course has 3 mid-term exams and 1 final exam. Initial grades are assigned based on the following scale - 75% from 3 mid-term exams (25% weight for each exam) 20% weight for homework, and 5% weight for attendance. Students who are satisfied with their initial grades can skip the final exam and their initial grades will be their final grades. Students who are not happy with their course grades can sit for the final exam. After the final exam they will receive the final grade which will be calculated based on the following scale - 30% weight for the final exam, 45% weight for 3 mid-term exams (15% weight for each mid-term) 20% weight for the homework and 5% weight for the attendance. Students going for the final exam option will have to take the final grade even if it is lower than their initial grades.

Times for the midterm exams will be announced in the class. Calculators that can be used for exams are given in the following link. These are the approved calculators for FE (Fundamentals of Engineering) certification exam also

Assignment of the final grade will be based on the following scale:

A	90 - 100
B	$80 < 90$
C	$70 < 80$
D	$60 < 70$
E	< 60

<u>Benefit for submitting homework on time:</u> Students who submit their homework on time will be given the higher grade if their total points are near the borderline between two grades.

Policy Regarding Dishonest Scholastic Work:

The University's Code of Academic Integrity holds the student fully responsible for the content and integrity of all academic work related to examinations, homework, term projects, laboratory reports, and any other grading component. Furthermore, the ethical principles of the engineering profession as enunciated in the codes of ethics of various engineering professional societies specifically prohibit dishonest work and/or plagiarism. Therefore, in the event that an instructor observes or is made aware of cheating taking place in this course, he/she will take action to make sure that those involved are subjected to the most severe disciplinary sanctions permitted by the University.

Accessibility and Accommodations:

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations.

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Students with disabilities or special needs who require reasonable accommodations to fully participate in course activities or meet course requirements must register with the S.A.L.T. Center (http://www.salt.arizona.edu/) or the Disability Resource Center (http://drc.arizona.edu/). If you qualify for special accommodations, please email or bring your letter of request to me as soon as possible.

Class Note Copyright: Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Providing student email addresses to a third party is not permitted. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA email to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of electronic resources provided by The University of Arizona. This conduct may also constitute copyright infringement.

THESE POLICIES WILL BE STRICTLY ENFORCED WITHOUT EXCEPTION.

ABET 2016 Criteria Course Classification Form

Outcome criteria	Level H M L	Relevant Activities
A. Apply mathematics, science and engineering principles	H	Finding Roots of Nonlinear Equations, System of Linear Equations, Curve Fitting, Numerical Differentiation and Integration, and Numerical Solution of Ordinary Differential Equations
B. Ability to design and conduct experiments and interpret data		
C. Ability to design a system, component, or process to meet desired needs		
D. Ability to function on multidisciplinary teams		
E. Ability to identify, formulate, and solve engineering problems	M	Some engineering problems are identified and solved.
F. Understanding of professional and ethical responsibility		
G. Ability to communicate effectively	M	Transfer of information through homework and exam.
H. The broad education necessary to understand the impact of engineering solutions in a global context		
I. Recognition of the need for and an ability to engage in life-long learning	M	Computer skill (MATLAB) learned here is important for life long learning
J. Knowledge of contemporary issues		
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	M	Computer programming language (like MATLAB) is introduced and used. Importance of this modern tool for solving engineering problem is emphasized.
L. Pass the FE exam as the first step towards professional registration.	M	Numerical analysis is tested in FE exam.
M. Be proficient in the major areas of civil engineering	L	Course content helps students to be proficient in other areas of civil engineering