DEPARTMENT OF SYSTEMS ENGINEERING
CISE – 301- Numerical Methods (Section 5)
Spring Semester (121)

Instructor	:	**Dr. A. Khoukhi**
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Class Times	:	**SMW (9 AM – 9:50 AM)**
Office Hours	:	**S M W** (11 AM- 12 PM) or by A**PPOINTMENT**

Catalog Description : Roots of nonlinear equations. Solutions of systems of linear algebraic equations. Numerical differentiation and integration. Interpolation. Least squares and regression analysis. Numerical solution of ordinary and partial differential equations. Introduction to error analysis. Engineering case studies.
Course Objectives: The course aims to introduce numerical methods used for the solution of engineering problems. The course emphasizes algorithm development and programming and application to realistic engineering problems.
Pre-requisite: ICS 101, & MATH 201
Textbook : "Numerical Methods for Engineers", Steven C. Chapra and Raymond P. Canale. 5th Edition, McGraw Hill , 2006
Ot**her references**
- K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Ed. Wiley 2004.
- J. Mathews and K. Fink, Numerical Methods Using Matlab, 4th Ed. Printice Hall 2004.

Course Outcomes: at the end of this course Student should be able to:
1. Use Taylor Series to approximate functions and evaluate the approximation errors.
2. Understand and program algorithms to locate the roots of equations.
3. Understand and program algorithms to solve linear system of equations.
4. Learn how to smooth collected engineering data using least squares method.
5. Use polynomials to interpolate collected engineering data or approximate function
6. Understand and program algorithms to evaluate the derivative or the integral of a given function and evaluate the approximation error involved.
7. Understand and program to solve engineering Ordinary Differential Equations (ODE) or Partial Differential Equations (PDE).
8. Understand relationships among methods, algorithms and computer errors.
9. Apply numerical and computer programming tools to solve common engineering problems.
10. Apply versatile software tools in attacking numerical problems.

Computer usage:
Students may use FORTRAN, MATLAB or C Language (PC or UNIX versions) or any other language to write programs to solve computer homework assignments.

ABET category: content as estimated by faculty member who prepared this course description.
- Mathematical Sciences: 1 credit
- Engineering Science: 2 credits

Important Notes:
- *University Rules regarding attendance will be strictly followed.*
- *Late HW submission will be penalized.*
- *It is your* ***entire responsibility to catch up with any material covered during a lecture you have missed*** *(see full message sent by department to all SE students)*
- ***Utilization of any electronic communication devices (Mobile, iPad, etc.) is strictly forbidden in classes, quizzes and exams.*** *Breaking this rule in class will carry the penalty of a full absence from that class and breaking it in a quiz or exam will entitle the instructor to file a case of cheating against you if he deems it to be justified.*
- *Practice the* ***"5P" rule*** *to maximize your chances of success!* **Proper Preparation Prevents Poor Performance**

#	**Course Outcomes**	Method of Assessment*	Program Outcomes **
1	Use Taylor Series to approximate functions and evaluate the approximations error	H, Q, E	a, e, k
2	Apply and program algorithms to locate the roots of equations.	H, Q, E ,P	a, e, k
3	Apply and program algorithms to solve linear system of equations	H, Q, E	a, e, k
4	Smooth engineering collected data using least squares method	H, Q, E	a, e, k
5	Use polynomials to interpolate collected engineering data or approximate functions	H, Q, E	a, e, k
6	Apply and program algorithms to estimate the derivative or the integral of a given function or engineering data and evaluate the approximation error.	H, Q, E	a, e, k
7	Understand and program to solve engineering Ordinary Differential Equations (ODE) or Partial Differential Equations (PDE)	H, Q, E,P	a, e, k
8	Understand relationships among methods, algorithms and computer errors.	H, Q, E	a, i, k
9	Apply numerical and computer programming to solve common engineering problems.	H, P	a, i, k
10	Apply versatile software tools in attacking numerical problems	P	a, i, k

* **Method of Assessments: H: Homework, Q: Quizzes, E: Exams, P: Projects, L: laboratories.**

** **CISE Program Learning Outcomes:**

a. Apply knowledge of mathematics, science, and engineering.
b. Design and conduct experiments, as well as analyze and interpret data;
c. Design a system component, or process to meet desired needs within realistic constraints
d. Function as a member of a multi-disciplinary team
e. Identify, formulate, and solve control and instrumentation Systems engineering problems
f. Understand and respect professional and ethical responsibility
g. Communicate effectively both orally and in writing
h. Understand the impact of engineering solutions in a global and societal context
i. Recognize the need for life-long learning, and an ability to engage in it
j. Have a knowledge of contemporary issues
k. Use updated techniques, skills and tools of control and Instrumentation Systems engineering throughout their professional careers.

Grading :

- Attendance 5 %
- Quizzes 8 %
- HWs / Comp Work 12 %
- Major I 20 % topics 1,2,3 (**Date:** Thursday 11 October 2012 **Time:** 10 AM – 12 PM)
- Major II 25 % topics 4,5,6 (**Date:** Thursday 6 December 2012 **Time:** 10 AM – 12 PM)
- Final 30 % topics 7,8,9 (Date set by **Registrar**, Duration= 2 hours)

TOPICS		No. of Lectures (50 min.)
1.	**Introductory material:** Absolute and relative errors, Rounding and chopping, Computer errors in representing numbers (sec 3.1-3.4). Review of Taylor series (sec 4.1),	4
2.	**Locating roots of algebraic equations:** Graphical Methods (Sec 5.1), Bisection method (Sec 5.2), Newton method (sec 6.2), Secant method (sec 6.3), Systems of nonlinear equations (6.5.2)*	6
3.	**Systems of linear equations:** Naïve Gaussian elimination(sec 9.2) Gaussian elimination with scaled partial pivoting and Tri-diagonal systems, Gauss-Jordan method (Sec 9.7)*	6
	MAJOR EXAM 1	
4.	**The Method of Least Squares;** Linear Regression (Sect 17.1), Polynomial Regression (17.2) Multiple Linear Regression (Sec 17.3)*	4
5.	**Interpolation:** Newton's Divided Difference method (Sec. 18.1), Lagrange interpolation (Sec 18.2), Inverse Interpolation (Sec 18.4)	4
6.	**Numerical Differentiation:** Estimating derivatives and Richardson's Extrapolation (sec. 23.1-23.2).	2.5
	MAJOR EXAM 2	
7.	**Numerical Integration:** Trapezoidal rule (sec. 21.1), Romberg algorithm (sec 22.2). Gauss Quadrature (sec 22.3)*	6
8.	**Ordinary differential equations:** Euler's method (sec 25.1), Improvements of Euler's method (sec 25.2), Runge-Kutta methods (sec.25.3), Methods for systems of equations (sec 25.4), Multistep Methods (Sec 26.2),: Boundary value problems (Sec. 27.1, 27.2.4).	9
9.	**Partial differential equations:** Elliptic Equations (sec 29.1-29.2) , Parabolic Equations (sec 30.1-30.4).	2.5
	Revision	1
	FINAL EXAM	