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DEPARTMENT OF SYSTEMS ENGINEERING

SE – 301- Numerical Methods-Section 3

First Semester (071)

Instructor	**:**	**Dr. Samir Hasan Al-Amer**
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Office Hours	**:**	**Sat 11-12:00, Sun 1:00-2:00 PM, Wed 10:00-12:00 or by appointment**

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 and MATH 201

Textbook : "Numerical Methods for Engineers", Steven C. Chapra and Raymond P. Canale. 5th Edition.

O**ther references:** W. Cheney and Kincaid, Numerical Mathematics and Computing.

Course Outcomes: at the end of this course Student should be able to:

1. Use Taylor Series to approximate functions and evaluate the approximations error.
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 engineering collected data using least square method.
5. Use polynomials to interpolate engineering collected 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.
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 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.

Important Notes:

- University Rules regarding attendance will be strictly followed.
- Absence from class does not excuse a missed quiz or homework assignment.
- Late homework will be penalized.

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Grading :

- class activities 5% (-1% per absence)
- HW + Computer Homework + project 10%
- Quizzes +Computer Quiz 25%
- Major I (Topics 1,2,3,4) 25% **(Nov 3, 2007 (Sat) 7:00 – 9:00 PM)**
- Final exam (Topics 8, 9) 35%

TOPICS:

1. **Introductory material:** 4 Lecturers
   absolute and relative errors, Rounding and chopping, Computer errors in representing numbers (sec 3.1-3.4)*.
   Review of Taylor series (sec 4.1),

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2. **Locating roots of algebraic equations:** 5 Lectures
   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)*

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3. **Systems of linear equations:** 5 Lectures
   Naïve Gaussian elimination(sec 9.2)
   Gaussian elimination with scaled partial pivoting
   and Tri-diagonal systems, Gauss-Jordan method (Sec 9.7)*

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4. **The Method of Least Squares;** 3.5 Lectures
   Linear Regression (Sect 17.1), Polynomial Regression (17.2)
   Multiple Linear Regression (Sec 17.3)*

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5. **Interpolation:** 3.5 Lectures
   Newton's Divided Difference method (Sec. 18.1),
   Lagrange interpolation (Sec 18.2), Inverse Interpolation (Sec 18.4)

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6. **Numerical Integration:** 5 Lecturers
   Trapezoid rule (sec. 21.1), Romberg algorithm (sec 22.2).
   Gauss Quadrature (sec 22.3)*

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7. **Numerical Differentiation:** 2 Lectures
   Estimating derivatives and Richardson's Extrapolation (sec. 23.1-23.2).

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8. **Ordinary differential equations:** 7 Lectures
   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).

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9. **Partial differential equations:** 2 Lectures
   Elliptic Equations (sec 29.1-29.2)and
   Parabolic Equations (sec 30.1-30.4).

   Revision 1 Lecture