METU - Department of Engineering Sciences
[ES 361] COMPUTING METHODS IN ENGINEERING

Dr. Berat Can Cengiz - beratcan@metu.edu.tr - ***Room:*** MM906

Course Hours: 8:40 - 11:30 Wednesday (MM-125)

Office Hours: 14:00 - 16:00 Wednesday (only by appointment)

Catalog Description: Mathematical modeling of engineering problems, Numerical solution of single variable equations, and systems of linear and nonlinear equations. Curve fitting and interpolating polynomials. Numerical differentiation and integration. Numerical solution of ordinary differential equations, optimization.

Textbooks: Chapra, S.C. and Canale, R.P., **Numerical Methods for Engineers**, McGraw-Hill, 7th Ed., 2015
Burden, R.L. and Faires, J.D., **Numerical Analysis**, Brooks-Cole, 9th Ed., 2010

Goals: The course is designed to equip students with the computational skills and tools needed to solve various engineering problems and obtain their solutions using computers.

Course Outline

1. **INTRODUCTION**
   - 1.1. Mathematical modeling of engineering problems: aim of the course
   - 1.2. Some concepts in approximations. The errors due to chopping, rounding, truncation.
2. **SOLUTION OF NONLINEAR EQUATIONS OF SINGLE VARIABLE**
   - 2.1. Bracketing methods
     - 2.1.1. Bisection method
     - 2.1.2. False-Position method
   - 2.2. Open methods
     - 2.2.1. Newton and Secant methods
     - 2.2.2. Fixed-point Iteration method
3. **SOLUTION OF LINEAR SYSTEM OF EQUATIONS**
   - 3.1. Gauss elimination methods (with and without pivoting)
   - 3.2. Gauss-Jordan Elimination method
   - 3.3. Jacobi method
   - 3.4. Gauss-Seidel method
4. **SOLUTION OF SYSTEM OF NONLINEAR EQUATIONS**
   - 4.1. Newton's method
5. **APPROXIMATION OF FUNCTIONS**
   - 5.1. Interpolation
     - 5.1.1. Lagrange Interpolating Polynomials
     - 5.1.2. Newton Interpolating Polynomials
   - 5.2. Curve Fitting
     - 5.2.1. Least-squares regression
6. **NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**
   - 6.1. Differentiation
     - 6.1.1. Forward
     - 6.1.2. Backward
     - 6.1.3. Central
   - 6.2. Integration
     - 6.2.1. Trapezoidal rule
     - 6.2.2. Simpson's rules
7. **NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**
   - 7.1. Initial Value Problems (IVP)
     - 7.1.1. Euler method
     - 7.1.2. Heun's (Modified Euler) method
     - 7.1.3. Runge-Kutta-2 method
     - 7.1.4. Runge-Kutta-4 method
   - 7.2. Boundary Value Problems (BVP)
     - 7.2.1. Shooting method
     - 7.2.2. Finite difference method

Please note that: Attendance will **NOT** be graded. If a student misses any of the exams without a legal reason, he/she receives zero for that exam; however, if the student has a legal reason, he/she must take the makeup exam, which will be given after the final. There will be only one and a common make-up exam after the final.

EXAMS AND GRADING POLICY	DATE	WEIGHT
Mid-Term Exam - 1	03.04.24	30%
Mid-Term Exam - 2	22.05.24	30%
Final Exam	To be announced	40%
Make-Up Exam	Usually One Week after the End of Final Week	