ECE 330: Computational Techniques

Course Offering – Spring Semester

Tuesday, Thursday: 11:00am – 12:15pm
Mandatory Recitation Period (50 min.): Wednesday, time TBD

Room: TBD

Instructor: Dr. Wolfgang Fink

Contact Information:

Instructor: Dr. Wolfgang Fink
Associate Professor
Edward & Maria Keonjian Endowed Chair
ECE Dept./BME Dept./SIE Dept.
Dept. of Ophthalmology and Vision Science

Email: wfink@email.arizona.edu
Phone: 520-621-8734
Office Hours: Wed 10am – Noon
Location: ECE Room #521
**Course Description:** This course provides students with the fundamentals of computational techniques for solving numerical problems. In particular students will become familiar with techniques for numerical differentiation, numerical integration, solving differential equations (e.g., Runge-Kutta method), solving systems of linear equations (e.g., Gauss-Jordan elimination), discretization of differential operators, aspects of numerical linear algebra (e.g., matrix inversion), root finding (e.g., Newton-Raphson method), and numerical optimization (least squares method, linear programming, and stochastic optimization techniques such as simulated annealing and genetic algorithms). In addition students will be provided with a basic working knowledge of the Matlab environment: They will learn how to create, edit, compile, and run programs in Matlab. Moreover, students will be provided with a basic working knowledge of Gnuplot: They will become familiar with 2D and 3D plotting techniques. Furthermore, students will be introduced to Numerical Recipes and the GNU Scientific Library.

**Course Prerequisites:** MATH 254, (MATH 223), PHYS 141, PHYS 142/3, PHYS 241, ECE 175 (if you do not meet the prerequisites criteria you may still be able to register after consulting with the instructor).

**Course Requirements:** Books and note readings, attendance (10% of final course grade), weekly homework assignments (20% of final course grade) including hands-on Matlab programming exercises, 2 written midterm exams (each 17.5% of final course grade), and one written final exam (35% of final course grade).

For enrollment contact Marisa Pope-Malings: undergradadvisor@ece.arizona.edu
**Required and Recommended Books:**

1. **Required:**
   WH Press, BP Flannery, SA Teukolsky, and WT Vetterling
   "Numerical Recipes in C: The Art of Scientific Computing"
   Cambridge University Press, Cambridge, NY

2. **Recommended:**
   RW Hamming
   "Numerical Methods for Scientists and Engineers"
   Second Edition

3. **Recommended:**
   W Bober and A Stevens
   "Numerical and Analytical Methods with MATLAB for Electrical Engineers"
   CRC Press (Taylor & Francis Group)

4. **Recommended:**
   E Kreyszig
   "Advanced Engineering Mathematics"
   9th Edition
   John Wiley & Sons, Inc.
Envisioned Detailed Course Description:

- **Basic working knowledge of Matlab**
  Students will become familiar with the *Matlab environment* and learn how to edit, compile, and run programs in Matlab.

- **Basic working knowledge of Gnuplot**
  Students will become familiar with the *Gnuplot environment* and learn how to generate 2D and 3D data plots.

- **Basic introduction to Numerical Recipes and GNU Scientific Library**

- **Numerical differentiation**
  Students will become familiar with *numerical differentiation* (*Two-Point formula and Three-point formula*).

- **Numerical integration**
  Students will become familiar with numerical integration techniques, such as: *Trapezoidal Rule, Simpson rule, Newton-Cotes Integration, Gauss-Legendre Integration.*

- **Transformation of Differential Equations and Euler Method**
  Students will become familiar with *transformation of differential equations*, and the *Euler Method* for solving the differential equations.

- **Improved Euler Method and Runge-Kutta Method**
  Students will become familiar with the *improved Euler Method* and the *Runge-Kutta Method* for solving the differential equations.

- **Method of Successive Over-Relaxation for solving systems of linear equations**
  Students will become familiar with the *discretisation of second order differential equations*, and the *Method of Successive Over-Relaxation (Liebmann Method)* for solving systems of linear equations.

- **Numerical Linear Algebra**
  Students will become familiar with the *Gaussian Elimination and Gauss-Jordan Elimination methods for solving systems of linear equations*, and for matrix inversion.

- **Root Finding**
  Students will become familiar with the *Newton-Raphson method, the Regula Falsi, the Secant method, and the Bisection method* to determine the roots of functions.

- **Numerical Optimization**
  Students will become familiar with the *method of least squares (also for curve-fitting), linear programming, and stochastic optimization techniques such as simulated annealing and genetic algorithms.*
**Grading:**

**Attendance:** 10% of final course grade based on sign-up sheets

**Homework:** 20% of final course grade

**Midterm and Final Exams:**
Two written midterm exams (each 17.5% of final course grade) will be interspersed in the above schedule, followed by a written final exam (35% of final course grade) at the end of the semester.

**Homework assignments and important course announcements will be posted on D2L.**

**Grade Distribution:**
- **A:** 85 – 100%
- **B:** 70 – 84%
- **C:** 55 – 69%
- **D:** 40 – 54%
- **E:** < 40%