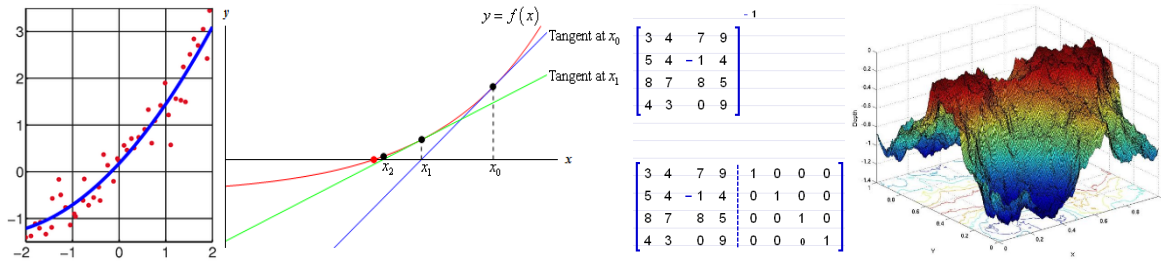


Curriculum Course



ECE 330A - Computational Techniques

Course Offering - Spring 2017

Tuesdays, Thursdays: 11:00 AM – 12:15 PM

Room: Chemistry #134

Mandatory Recitation Period (50 min.): Wednesdays, 3:00 PM – 3:50 PM

Room: Harvill #305

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 Sydney B. Donaldson: undergradadvisor@ece.arizona.edu

Instructor and Contact Information:

Instructor: Dr. Wolfgang Fink

Associate Professor

Edward & Maria Keonjian Endowed Chair

ECE Dept./BME Dept./SIE Dept./AME Dept.

Dept. of Ophthalmology and Vision Science

Email: wfink@email.arizona.edu

Phone: 520-621-8734

Office Hours: Wed 10:00 AM – 12:00 PM

Office Location: ECE Room #521

<http://ece.arizona.edu/wolfgang-fink>

Course homepage: <https://d2l.arizona.edu/>

Instructor homepage: <http://ece.arizona.edu/wolfgang-fink>

D2L information: <https://d2l.arizona.edu/>

Teaching Assistant: Siteng “Star” Chen

Email: sitengchen@email.arizona.edu

Course Objectives and Expected Learning Outcomes:**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*.

Specific Outcomes of Instruction: *By the end of this course, the student will be able to:*

1. Use MATLAB for data manipulation, data plotting, and basic programming.
2. Use Gnuplot to generate 2D and 3D plots.
3. Work with Numerical Recipes and the GNU Scientific Library.
4. Numerically differentiate and integrate functions with several techniques of different accuracy and efficiency.
5. Transform systems of differential equations and solve them numerically with several techniques of increasing numerical accuracy.
6. Solve systems of linear equations efficiently and invert matrices.
7. Determine roots of functions numerically with several methods.
8. Perform least squares optimization.
9. Perform linear, polynomial, and general curve fits.
10. Solve optimization problems amenable to linear programming.
11. Solve high-dimensional, multivariate optimization problems in the presence of multiple/infinite local minima that cannot be solved with deterministic, gradient-descent based optimization techniques.

Relationship to Student Outcomes: *ECE 330A contributes directly to the following specific Electrical and Computer Engineering Student Outcomes of the ECE Department (H=HIGH, M=MEDIUM, L=LOW):*

- (a) an ability to apply knowledge of mathematics, science, and engineering (H)
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data (M)
- (e) an ability to identify, formulate, and solve engineering problems (M)
- (i) a recognition of the need for, and an ability to engage in life-long learning (L)
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (H).

Absence and Class Participation Policy: The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/2015-16/policies/classatten.htm>.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored.

See: <http://uhap.web.arizona.edu/policy/appointed-personnel/7.04.02>

Participating in course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. Students who miss class due to illness or emergency are required to bring documentation from their healthcare provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

Course Communications: Homework assignments and important course announcements will be posted on D2L.

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
Dover Publications, Inc., New York

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.

Assignments and Examinations: Schedule/Due Dates:

Homework: 20% of final course grade (*Homework assignments will be posted on D2L*).

Midterm and Final Exams: Two written midterm exams will be given during the semester. Each is worth 17.5% of the final course grade. There will be one final exam at the end of the semester worth 35%.

FINAL EXAM DATE: TUESDAY, MAY 9, 10:30 AM – 12:30 PM

Final Examination Information: The final exam will be held on Tuesday, May 9, 10:30 AM – 12:30 PM. Final exam schedules for the University may be found at: <http://www.registrar.arizona.edu/students/courses/final-exams>

Grading Scale and Policies:

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).

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.

Grade Distribution:

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

Requests for incompletes (I) and withdrawal (W) must be made in accordance with University policies which are available at <http://catalog.arizona.edu/2015-16/policies/grade.htm#I> and <http://catalog.arizona.edu/2015-16/policies/grade.htm#W> respectively.

Scheduled Topics/Activities:

Below is the tentative weekly schedule for the class. Assignment due dates and midterm exam dates are TBD and will be announced via D2L throughout the semester.

Week	Topic	Assignment Due Date (if applicable)
Week 1	First Day of Class, Wednesday, January 11 - Introduction to Course; Introduction to Matlab & Gnuplot	TBD
Week 2	Introduction to Matlab & Gnuplot; Introduction to Numerical Recipes and GNU Scientific Library; Numerical differentiation (two-point formula, improved two-point formula, three-point formula)	TBD
Week 3	Numerical integration: Trapezoidal Rule, Simpson Rule, Gauss-Legendre	TBD
Week 4	Transformation of differential equations; Euler Method; Improved Euler Method; Runge-Kutta Method	TBD
Week 5	Method of Successive Over-Relaxation; Liebmann method; Electric Lens study system; Solving of linear equations	TBD
Week 6	Numerical linear algebra: Gaussian Elimination; Gauss-Jordan Elimination; Matrix inversion	TBD
Week 7	Q&A for 1 st Midterm Exam; First Midterm Exam	TBD
Week 8	Root finding: Newton-Raphson method, Regula Falsi, Secant method, Bisection method	TBD
Week 9	No class – Spring recess	TBD
Week 10	Numerical optimization: Least Squares; Linear Programming	TBD
Week 11	Numerical optimization: Linear Programming; Multi-dimensional Newton Raphson method; Introduction to stochastic optimization	TBD
Week 12	Numerical optimization: Simulated Annealing	TBD
Week 13	Q&A for 2 nd Midterm Exam; Second Midterm Exam	TBD
Week 14	Numerical optimization: Simulated Annealing; Genetic Algorithms	TBD
Week 15	Numerical optimization: Genetic Algorithms; Multi-dimensional optimization scenarios	TBD
Week 16	Q&A for Final Exam; Last day of Class, Wednesday, May 3	
FINAL EXAM	TUESDAY, May 9, 10:30 AM – 12:30 PM	

Classroom Behavior Policy: To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (i.e. texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Threatening Behavior Policy: The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to one's self.

See: <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Accessibility and Accommodations: Our goal in this classroom is 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. For additional information on Disability Resources and reasonable accommodations, please visit <http://drc.arizona.edu/>.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

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.

Code of Academic Integrity: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism available at: <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

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. 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 student email addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy: The University is committed to creating and maintaining an environment free of discrimination, <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>.

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.