**Department of Electrical and Computer Engineering**
**University of Massachusetts Amherst**

# E&C-ENG 201: Analytical Tools for ECE

**Description**: Complex numbers and exponentials. First-order differential equations. Matrices and systems of linear equations. Vector spaces and linear transformations. 2nd-order linear differential equations and the Laplace transform. Systems of differential equations. Applications to modeling, analysis, and design of ECE systems. (4 credits)

**Prerequisite:** MATH 132

**Course Format:** Three 50-minute lectures and one 75-minute discussion per week.

**Objectives:** Students completing this course will be able to:

1. Use complex numbers and complex exponential functions, including being fluent in complex number arithmetic and conversion between rectangular and polar forms.
2. Understand and solve simple first order differential equations.
3. Use matrix manipulation rules.
4. Understand basic concepts in vector spaces.
5. Understand and solve simple second order differential equations.
6. Use Laplace transforms for solving simple differential equations.
7. Use matrices to analyze systems of linear differential equations.
8. Apply linear algebra and differential equations to the modeling, analysis, and design of electrical and computer systems.

**Instructors:**

Ramakrishna Janaswamy (Lectures, Office hours: Tu 3:00-5:00 pm)
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**Teaching Assistants:**

Hua Bai (Office hours: Thu 1:00-3:00 pm)
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**Textbook:** E. Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Inc., 2011.

**Tentative Week-by-week topics outline:**

| Week | Topics | Readings from text |
|---|---|---|
| 1 | Introduction; Complex numbers and complex number arithmetic; rectangular and polar forms. | Sec. 13.1, 13.2. |
| 2 | Rational functions and roots, complex exponentials, trigonometric functions, complex logarithm. Phase and its relation to time delay. | 13.5-7. |
| 3 | Matrices: Definitions, notations, basic algebra. Elementary operations. | Sec. 7.1-7.2. |
| 4 | Matrices: Inversion; Determinants; Solution of linear equations | Section 7.6-7.8. |
| 5 | Linear transforms; Eigenvalues and eigenvectors; Matrix diagonalization; applications in signal processing and systems modeling. | Sec. 8.1-8.4. |
| 6,7 | First order linear equations; Existence and uniqueness of solutions. Application to RC and RL circuits. | Sec. 1.4-1.5, Sec. 1.7. |
| 8 | Basic concepts of differential equations; Separable equations. | Sec. 1.1-1.3. |
| 9 | General theory of linear differential equations; homogeneous linear equations. Application to RLC circuits. | Sec. 2.1-2.4, 2.9. |
| 10 | The method of undetermined coefficients; Variation of parameters. | Sec. 2.7, Sec. 2.10 |
| 11,12 | Laplace transforms: definition; properties and applications to linear differential equations; applications in circuit analysis. | Sec. 6.1-6.6. |
| 13 | Systems of differential equations; First order linear systems; Vector formulation. | Sec. 4.0-4.3 |

**Grading Policy**: The course grade will be based on the following components:

1. Eight homework assignments - 15% of total grade. (*Note*: Some homework assignments will require the use of MATLAB or other mathematical software.)
2. Two Midterm Exams – 50% of total grade (25% each).
    a. Midterm1: Fri Oct xx, 7:00-8:15 pm, Integrated Science Building, Rm 135
    b. Midterm2: Tue Nov xx, 7:00-8:15 pm, Integrated Science Building, Rm 135
3. Two-Three Discussion Quizzes - 5% of total grade.
4. Final Exam – 30% of total grade.

(Please see topics outline for assignment schedule.)

**Academic Honesty:** Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating,

fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent (http://www.umass.edu/dean_students/codeofconduct/acadhonesty/).

**Accommodation Policy:** The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.

**Inclusivity and Diversity:** The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued for any reason, please speak with the instructor privately. If you wish to communicate anonymously, you may do so in writing or speak with Dr. Paula Rees, Director of Engineering Diversity Programs (rees@umass.edu, 413.545.6324, Marston 128). We are all members of an academic community where it is our shared responsibility to cultivate a climate where all students/individuals are valued and where both they and their ideas are treated with respect.