

**Course Syllabus**  
**ECE 455 – Mathematical Models in Electrical Engineering**  
**Department of Electrical & Computer Engineering**

<b><u>1. Course Number and Name:</u></b>	ECE 455 – Mathematical Models in Electrical Engineering
<b><u>2. Credit Units/Contact Hours:</u></b>	3/3
<b><u>3. Course Coordinator:</u></b>	Ali Amini

**4. Text, References & Software**

**Recommended Text:**

Advanced Engineering Mathematics, Erwin Kreyszig, 9<sup>th</sup> ed., wiley, ISBN-978-0471488859.

**Additional References:**

Mathematical Models in Electrical Engineering-Complex Variables, Linear Algebra, Partial Differential Equation, Ali Amini, May 2016 (download from ECE Dept. website).

**Software:**

MATLAB: Control, and Partial Differential Equation Tool Boxes, Math Works.

**Internet Resources:**

<http://hpme12.me.edu/matlab/html/>

**5. Specific Course Information**

**a. Course Description**

The advanced topics in mathematics in the areas of Complex Variables, Linear Algebra, Partial Differential Equations and Series Solutions to Differential Equations are discussed. These mathematical tools are used to model and solve Electrical Engineering related problems in the areas of Circuits, Controls, Electromagnetics, Solid State and Communication Theory.

**b. Prerequisite by Topic**

Students taking this course should have complete familiarity with the topics of analog Linear Systems (ECE 350). Specifically students should be familiar with convolution, Fourier Series, Fourier Transforms, and Laplace Transforms in analyzing system characteristics and response. Students should also know the basic concepts taught in algebra, calculus and differential equations courses. These basic concepts include, but are not limited to, limit theory, differentiation, integration, sequences, series, and various techniques for solving differential equations. Students are also assumed to have basic knowledge of MATLAB.

**c. Required Course**

**6. Specific Goals for the Course**

**a. Specific Outcomes of Instructions** – After completing this course the students should be able to:

1. Perform arithmetic operations on complex numbers, given in rectangular or polar form
2. Understand the concept of complex functions, domain and range.
3. Define the limit of a complex function, analytic functions and determine the derivative of complex functions using Cauchy Riemann conditions and rules of taking derivative.

4. Write the parametric equation of a line.
5. Evaluate line integrals in a complex plane, and learn and apply the Residue theorem.
6. Apply complex variables to solve problems in circuits, controls, etc.
7. Define different types of matrices, such as identity matrix, a row matrix, a column matrix, a square matrix, a triangular matrix, a zero matrix, etc.
8. Perform arithmetic operations on matrices.
9. Define and evaluate eigenvalues and eigenvectors.
10. Perform transformations.
11. Apply linear algebra in modeling and solving state variable equations in the time domain and the S domain.
12. Understand the basic concept of partial differential equations.
13. Solve different partial differential equations using different methods including but not limited to separation of variables.
14. Understand D'Alembert's solution to the wave equation and apply partial differential equations to electromagnetic and solid state theory.

**b. Relationship to Student Outcomes**

This supports the achievement of the following student outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**7. Topics Covered/Course Outline**

1. Complex Variables. Definitions, complex numbers, arithmetic operations, complex functions, limits, analytic function, derivative, Cauchy Riemann conditions, line integral, complex series, Residue theorem, and application to electrical engineering problems.
2. Linear Algebra. Definitions, matrix, determinant, arithmetic operations, eigenvalues and eigenvectors, transformations, state variable equations.
3. Partial Differential Equations. Definitions, method of separation of variables, D'Alembert's solution to the wave equation, Laplace transformations, and application to electrical engineering problems.

**Prepared by:**

Ali Amini, September 2018