Engineering Mathematics I

Introduction to Essentials of Complex Analysis and Integral Transforms

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Fall 2026

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Course at a Glance

Basic Information

- Credits: 2   Hours: 32
- Category: Major basic course
- Prerequisite: Advanced Mathematics (Calculus)
- Textbook: Kreyszig, *Advanced Engineering Mathematics* (10th ed.)

Supplementary Resources (Wolfram Media)

- *Essentials of Complex Analysis*
- *Laplace Transforms in Theory and Practice*

Target Audience

Second-year undergraduate students majoring in Electrical Engineering

Learning Objectives

On successful completion, students will be able to:

1. Master the theory of complex functions and their integrals, and apply them to engineering problems involving phasors, contour integration, and signal analysis.
2. Understand Laplace transforms and their properties, and use them to solve ODEs arising in circuit analysis and control systems.
3. Understand Fourier and integral-transform methods used in signal analysis, systems, and engineering applications.
4. Solve engineering problems by selecting and applying appropriate mathematical techniques.
5. Recognize the importance of advanced mathematics in electrical engineering.

Overall Structure (16 Two-Hour Modules)

Block	Topic	Modules	Hours	Instructor
I	Complex Analysis and Applications	L01 – L08	16	Dr. Tianyu Dong
II	Integral Transforms, ODEs, and Engineering Applications	L09 – L16	16	Dr. Jiawei Wang

Emphasis throughout

Continuous connection to Electrical Engineering applications:
phasors, complex potentials, transfer functions, RLC transients,
control systems, Fourier/Laplace analysis, and PDE-based engineering models. L03 and L16 also provide optional and reference frames beyond the core route.

Block I: Complex Analysis and Applications (L01–L08)

L	Topic	Key Focus + EE Link
1	Complex numbers and complex plane	Arithmetic, geometry, and phasor intuition
2	Complex functions and analyticity	Domain, limits, continuity, and mapping
3	Elementary complex functions	Exponential, trigonometric, hyperbolic, and logarithmic forms
4	Integrals and Cauchy theorems	Path independence and contour integration
5	Power series and Taylor expansions	Local representation of analytic functions
6	Laurent series and residues	Singularities and coefficient extraction
7	Conformal mappings	Geometry of analytic transformations
8	Applications of complex analysis	Real integrals, contour design, and engineering interpretation

Block II: Integral Transforms, ODEs, and Engineering Applications (L09–L16)

L	Topic	Key Focus + EE Link
9	Integral transforms and Fourier transform	Frequency-domain representations and spectra
10	Foundations of Laplace transform	Definition, convergence, and transform pairs
11	Laplace transform properties	Shifts, scaling, derivatives, convolution
12	Inverse Laplace transform	Partial fractions and contour inversion
13	Solving ODEs with Laplace transform	Initial-value problems and transient response
14	Systems, convolutions, and PDEs	Input-response models and distributed systems
15	Control systems and engineering applications	Stability, frequency response, and feedback control
16	Advanced topics and review	Synthesis, extensions, and final revision

Assessment Structure

Item	%	Details
Homework	10%	Assignments + participation
Project research	10%	Apply one major topic to an EE problem (circuit, signal, or EM application)
Quiz	10%	Performance-based
Final exam	70%	Written examination

Project suggestion window

Assign around the transition from complex analysis to transforms, typically near L07–L10, so students can choose a topic spanning Complex Analysis, Fourier, or Laplace methods.

Next » What is Complex Analysis?