Programme: B.E. Electrical and Electronics Engineering			
Complex Analysis, Transform Techniques and Optimization			
Course Code	**1BMATEE301**	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	III
Teaching Hours/Week (L:T:P)	42:28:0	CIE Marks	50
Total Hours of Pedagogy L /T/P/(SL&TW):	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcomes

At the end of the course, the student will be able to:

CO1: Apply the concepts of analytic functions, Cauchy-Riemann equations, complex integration, Cauchy's theorem, and Cauchy's integral formula to solve engineering and mathematical problems involving complex variables.

CO2: Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties.

CO3: Utilize Fourier transforms and Z-transforms, including their inverse transforms and properties, to analyse signals and solve difference equations arising in engineering applications.

CO4: Apply probability distributions, sampling theory, and statistical hypothesis testing techniques for analysing uncertainty and making data-driven decisions.

CO5: Formulate and solve linear programming problems using graphical, simplex, and Big-M methods to obtain optimal solutions in engineering and management applications.

Module-1

Complex Analysis: Review of a function of a complex variable, limits, continuity and differentiability. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms and consequences. Construction of analytic functions by Milne-Thomson method, Problems on electric flux.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's integral formula and problems.

Number of Hours: 08+05

Module-2

Fourier Series: Periodic functions, Euler's Formula, Conditions for Fourier expansion (Dirichlet's condition), Fourier series of functions i) having points of discontinuity, ii) with period 2π, iii) with change of interval (arbitrary period) and iv) Even and odd functions. Half rang Fourier series. Practical harmonic analysis.

Number of Hours:08+05

Module-3

Infinite Fourier transforms: Definition, Fourier transforms, Fourier sine, and cosine transforms. Inverse Fourier Transforms, inverse Fourier sine and cosine transforms. Problems.

Z-transforms: Definition, Standard Z-transforms, Damping, and shifting rules, Statements of initial value theorem and Final Value Theorem. Inverse Z-transform and applications to solve difference equations.

Number of Hours:09+06

Module-4

Probability Distributions: Review of basic probability theory, Random variables-discrete and continuous. Probability distribution function, cumulative distribution function, Mathematical Expectation-mean and variance. Repeated Trials- Binomial, Poisson, Normal and Exponential distribution (without proofs for mean and SD).

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test

of hypothesis for means, single proportions only. Student's t-distribution, Chi-square distribution as a test of goodness of fit.

Number of Hours: 09+06

Module-5

Linear Programming Problems: Introduction to optimization techniques, formulation of the problems. Introduction to Linear programming, graphical solution, solution by simplex and Big M method.

Number of Hours:08+06

Textbooks

(i)Higher Engineering Mathematics, B.S. Grewal, 45th Edition, Khanna Publishers.
(ii)Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India.
(iii)Higher Engineering Mathematics, H.K. Dass and Er. Rajnish Verma, S. Chand Publications.

Reference books

(i)Complex Variables and Applications by James Ward Brown and Ruel V. Churchill, McGraw-Hill Education.
(ii) Fourier Series and Boundary Value Problems by Ruel V. Churchill and James Ward Brown.
(iii)Probability and Statistics for Engineers and Scientists by Ronald E. Walpole et al., Pearson Education.
(iv)Operations Research by Hamdy A. Taha, Pearson Education.
(v) Schaum's Outline of Complex Variables, McGraw-Hill.

Web links and Video Lectures (e-Resources):

(i)NPTEL Courses on Engineering Mathematics
(ii)MIT Open Course Ware Mathematics
(iii)SWAYAM Online Courses.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

(a) Flipped Classroom Approach

(i) Students review video lectures and reading materials before class.
(ii) Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.

(b) Problem-Based Learning (PBL)

Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.

(c) ICT-Enabled Teaching (may be conducted in Tutorial hours)

Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.

(d) Collaborative Learning (may be conducted in Tutorial hours)

Group assignments and mini-projects on optimization models and transform applications.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.
In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.
It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 levels)	10
2.	GATE-based Aptitude Test	15

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding	Understanding of Concepts
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively	Problem Solving Ability
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors	Mathematical Accuracy
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation	Presentation & Organization

Suggested Learning Activities may include (but are not limited to):

Course Project, Case Study Presentation, Programming Assignment, Tool/Software Exploration, Literature Review, Open Book Test (preferably at RBL4 and RBL5 levels),GATE-based Aptitude Test, Assignment (at RBL3, RBL4, or RBL5 levels), Any other relevant and innovative academic activity, Use of MOOCs and Online Platforms.

Suggested Innovative Delivery Methods may include (but are not limited to):

Flipped Classroom, Problem-Based Learning (PBL), Case-Based Teaching, Simulation and Virtual Labs, Partial Delivery of course by Industry expert/ industrial visits,ICT-Enabled Teaching, and Role Play.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours per Semester**
1.	Group Assignment on Applications of Complex Variables in Electrical Engineering (AC circuits, electric flux, potential theory)	20
2.	MATLAB/Python Exploration of Fourier and Z-Transforms	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours/ Semester**
1.	Conformal transformations: Discussion of transformations: $w = z^2, w = e^z, w = z + \frac{1}{z}, z \neq 0$, Bilinear transformation	30
2.	Complex form of Fourier series	
3.	Convolution theorem for Fourier transforms and Z transforms. Applications of transforms to boundary value problems	
4.	Joint probability distributions.	
5.	Dual simplex method.	

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

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