

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)	70 (3:2:0)	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	120 (42:28:0:50)	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3
Course outcome (Course Skill Set): At the end of the course, the student will be able to: C01: 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. C02: Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties. C03: Utilize Fourier transforms and Z-transforms, including their inverse transforms and properties, to analyze signals and solve difference equations arising in engineering applications. C04: Apply probability distributions, sampling theory, and statistical hypothesis testing techniques for analyzing uncertainty and making data-driven decisions. C05: 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. 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 (statement only) and problems.			
Number of Hours:8+5T			
Module-2: Fourier Series			
Periodic functions, Euler's Formula, Conditions for Fourier series expansion(Dirichlet's condition), Fourier series of functions -having points of discontinuity, with period 2π , with change of interval (arbitrary period) and, Even and odd functions. Half range Fourier series. Practical harmonic analysis.			
Number of Hours:8+5T			
Module-3: Fourier transforms and Z-transforms			
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 (statements only). Inverse Z-transform and applications to solve difference equations.			
Number of Hours:9+6T			

Module-4: Probability distributions and Sampling theory
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 single means, single proportions. Student's t-distribution, Chi-square distribution as a test of goodness of fit. Number of Hours:9+6T
Module-5: Linear Programming Problems
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:8+6T
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Textbooks: (i) Higher Engineering Mathematics, B.S. Grewal, 45th Edition, Khanna Publishers. (ii) Operations Research: An Introduction, Hamdy A. Taha, Pearson Education. (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) Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India. (iii) Fourier Series and Boundary Value Problems by Ruel V. Churchill and James Ward Brown. (iv) Probability and Statistics for Engineers and Scientists by Ronald E. Walpole et al., Pearson Education. (v) Operations Research by Hamdy A. Taha, Pearson Education. (vi) Schaum's Outline of Complex Variables, McGraw-Hill.
Web links and Video Lectures (e-Resources): • NPTEL Courses on Engineering Mathematics • MIT OpenCourseWare Mathematics • 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. 1. Flipped Classroom Approach ○ Students review video lectures and reading materials before class. ○ Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models. 2. Problem-Based Learning (PBL) ○ Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.

3. **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.
4. **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 and RBL4 levels based on Team Work(TW) activities.	10
2.	GATE-based Aptitude Test	15

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

Rubrics for Learning Activity–1: Assignment (10 Marks)

Performance Indicator	Superior (10)	Good (8)	Fair (6)	Needs Improvement (5)
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation

Rubrics for Learning Activity–2: GATE-Based Aptitude Test (15 Marks)

Performance Indicator	Superior (15)	Good (12)	Fair (10)	Needs Improvement (8)
Quantitative Aptitude	$\geq 90\%$ correct responses	75–89% correct	60–74% correct	$< 60\%$ correct
Analytical Thinking	Excellent logical reasoning and interpretation	Good reasoning ability	Moderate reasoning	Weak reasoning
Time Management	Completes all questions within allotted time	Completes most questions	Requires additional time	Unable to complete
Accuracy & Precision	Very high accuracy	Good accuracy	Moderate accuracy	Low accuracy

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 / Semester
1.	Group Assignment on Applications of Complex Variables in Electrical Engineering (AC circuits, electric flux, potential theory)	5
2.	MATLAB/Python Exploration of Fourier and Z-Transforms	5
3.	Mini Project on Linear Programming Models in Engineering Applications	5
4.	Case Study on Signal Processing using Transform Techniques	5
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 transformations	6
2.	Complex form of Fourier Series	6
3.	Convolution theorem for Fourier transforms and Z transforms. Applications of transforms to boundary value problems	6
4.	Joint probability distributions.	6
5.	Dual simplex method.	6

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).