GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02), INDUSTRIAL ENGINEERING (15) & MECHANICAL ENGINEERING (19)

COMPLEX VARIABLES AND NUMERICAL METHODS

SUBJECT CODE: 2141905

B.E. 4th SEMESTER

Type of course: Engineering Mathematics

Prerequisite: As a pre-requisite to this course students are required to have a reasonable mastery over multivariable calculus, differential equations and Linear algebra

Rationale:
Mathematics is a language of Science and Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Complex Numbers and Functions: Exponential, Trigonometric, De Moivre's Theorem, Roots of a complex number ,Hyperbolic functions and their properties, Multi-valued function and its branches: Logarithmic function and Complex Exponent function Limit ,Continuity and Differentiability of complex function, Analytic functions, Cauchy-Riemann Equations, Necessary and Sufficient condition for analyticity, Properties of Analytic functions, Laplace Equation, Harmonic Functions, Harmonic Conjugate functions and their Engineering Applications	10	24
2	Complex Integration: Curves, Line Integral(contour integral) and its properties, Cauchy-Goursat Theorem, Cauchy Integral Formula, Liouville Theorem (without proof), Maximum Modulus Theorems(without proof)	04	10
3	Power Series: Convergence(Ordinary, Uniform, Absolute) of power series, Taylor and Laurent Theorems (without proof), Laurent series expansions, zeros of analytic functions , Singularities of analytic functions and their classification Residues: Residue Theorem, Rouche's Theorem (without proof)	05	12
4	Applications of Contour Integration: Evaluation of various types of definite real integrals using contour	02	5

	integration method		
5	Conformal Mapping and its Applications: Conformal and Isogonal mappings , Translation, Rotation & Magnification, Inversion, Mobius(Bilinear) , Schwarz-Christoffel transformations	03	7
6	Interpolation: Finite Differences, Forward, Backward and Central operators, Interpolation by polynomials: Newton's forward ,Backward interpolation formulae, Newton's divided Gauss & Stirling's central difference formulae and Lagrange's interpolation formulae for unequal intervals	04	10
7	Numerical Integration: Newton-Cotes formula, Trapezoidal and Simpson's formulae, error formulae, Gaussian quadrature formulae	03	7
8	Solution of a System of Linear Equations: Gauss elimination, partial pivoting , Gauss-Jacobi method and Gauss-Seidel method	03	7
9	Roots of Algebraic and Transcendental Equations : Bisection, false position, Secant and Newton-Raphson methods, Rate of convergence	03	7
10	Eigen values by Power and Jacobi methods	02	4
11	Numerical solution of Ordinary Differential Equations: Euler and Runge-Kutta methods	03	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
10%	15%	20%	20%	35%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Reference Books:

1. R. V. Churchill and J. W. Brown, Complex Variables and Applications (7th Edition), McGraw-Hill (2003)
2. J. M. Howie, Complex Analysis, Springer-Verlag(2004)
3. M. J. Ablowitz and A.S. Fokas, Complex Variables-Introduction and Applications, Cambridge University Press, 1998 (Indian Edition)
4. E. Kreyszig, Advanced Engineering Mathematics(8th Edition), John Wiley (1999)
5. S. D. Conte and Carl de Boor, Elementary Numerical Analysis-An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980
6. C.E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley,1981
7. Gerald C. F. and Wheatley,P.O., Applied Numerical Analysis (Fifth Edition), Addison-Wesley, Singapore, 1998.
8. Chapra S.C, Canale, R P, Numerical Methods for Engineers **,** Tata McGraw Hill, 2003

Course Outcome:

After learning the course the students should be able to:

- evaluate exponential, trigonometric and hyperbolic functions of a complex number
- define continuity, differentiability, analyticity of a function using limits. Determine where a function is continuous/discontinuous, differentiable/non-differentiable, analytic/not analytic or entire/not entire.
- determine whether a real-valued function is harmonic or not. Find the harmonic conjugate of a harmonic function.
- understand the properties of Analytic function.
- evaluate a contour integral with an integrand which have singularities lying inside or outside the simple closed contour.
- recognize and apply the Cauchy's integral formula and the generalized Cauchy's integral formula.
- classify zeros and singularities of an analytic function.
- find the Laurent series of a rational function.
- write a trigonometric integral over $[0, 2\pi]$ as a contour integral and evaluate using the residue theorem.
- distinguish between conformal and non conformal mappings.
- find fixed and critical point of Bilinear Transformation.
- calculate Finite Differences of tabulated data.
- find an approximate solution of algebraic equations using appropriate method.
- find an eigen value using appropriate iterative method.
- find an approximate solution of Ordinary Differential Equations using appropriate iterative method.

List of Open Source Software/learning website:

http://ocw.mit.edu/resources/res-18-008-calculus-revisited-complex-variables-differential-equations-and-linear-algebra-fall-2011/part-i/
http://nptel.ac.in/courses/111105038/
http://nptel.ac.in/courses/111104030/
http://nptel.ac.in/courses/111107063/
http://nptel.ac.in/courses/111101003/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.