22EE310	Numerical Methods and Complex Variables

Category	L	T	P	Credit
BSC	3	1	0	4

Preamble

An Electrical engineering student needs to know sufficient numerical tools and techniques for solving engineering problems arises in their field. This course aims at developing the ability to formulate an engineering problem in a mathematical form appropriate for subsequent computational treatment and to choose an appropriate numerical approach. Analytic functions and Contour integration are extremely important while creating engineering models in control systems, communication systems, searching algorithms. The course is designed to impart the knowledge and understanding of the above concepts to Electrical Engineers and apply them in their areas of specialization.

Prerequisite

- NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Solve single non-linear algebraic, transcendental equation numerically.	TPS3	80	75
CO2	Solve system of linear equations numerically	TPS3	80	75
CO3	Solve the initial value problems in ODE numerically using single step and multi-step methods.	TPS3	80	75
CO4	Solve the boundary value problems in PDE using finite difference methods.	TPS3	80	75
CO5	Construct complex potential function and observe the behaviour using conformal mapping.	TPS3	75	70
CO6	Determine the value of integrals of functions of complex variable .	TPS3	75	70

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2

CO1	**S**	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**
CO2	**S**	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**
CO3	**S**	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**
CO4	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**
CO5	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**
CO6	**S**	**M**	**M**	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1						Assessment 2						Terminal(%)		
	Written Test 1			Assignment 1			Written Test 2			Assignment 2					
TPS	R	U	A	R	U	A	R	U	A	R	U	A	R	U	A
CO1	21%			100%									10%		
CO2	21%												10%		
CO3	33%												17%		
CO4	25%												13%		
CO5							50%			100%			25%		
CO6							50%						25%		
TOTAL															

*Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

Solution to a Single Non-linear Equation and a System of Linear Equations: Introduction to Numerical Solution – The Bisection Method - Fixed point iteration method – Newton Raphson method – Crout's Decomposition Method - Gauss Jacobi Method – Gauss Seidel methods

Numerical Solution of ODEs: Euler's method – Modified Euler's method – Taylor's Method- Runge-Kutta methods of order 4 – Predictor corrector methods – Adam's predictor corrector formula – Milne's Predictor corrector formula. **Numerical Solution of PDEs:** Classification of Second order equation - Solution to Elliptic, Parabolic and Hyperbolic PDEs

Complex Differentiation: Functions of complex variable – Analytic functions – C-R equations – Conjugate harmonics – Standard Transformations – Conformal Transformations – z^2, 1/z, az+b – Bilinear Transformations

Complex Integration: Cauchy's Theorem - Cauchy's integral formula – Taylor's Series - Laurent's series – Zeros of Analytic function – Singularities - Residues — Cauchy's residue theorem – Contour Integration.

Text Books

1. Steven C. Chapra, Raymond P. Canale, "Numerical Methods for Engineers", 7th Edition, McGrawHill Higher Education,2016.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2012.

Reference Books & web resources

1. Richard L Burden and Douglas J Faires, "Numerical Analysis", Thomas Learning, New York, 2017.
2. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Cengage Learning, USA, 2018.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley, 10th Edition, 2017
4. Mathews J. H. and Howell R. W, "Complex Analysis for Mathematics and Engineering", Narosa Publishing House, New Delhi, 2012

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Solution to a Single Non-linear Equation and a System of Linear Equations**	
1.1	Introduction to Numerical Solution	1
1.2	The Bisection Method	1
1.3	Fixed point iteration method	1
	Tutorial	**1**
1.4	Newton Raphson method	1
1.5	Crout's Decomposition Method	2
	Tutorial	**1**
1.6	Gauss Jacobi Method	1
1.7	Gauss Seidel methods	1
2	**Numerical Solution of ODEs and PDEs**	

Module No.	Topic	No. of Periods
2.1	**Numerical Solution of ODEs** : Euler's method and Modified Euler's method	1
	Tutorial	**1**
2.2	Taylor's Method	1
2.3	Runge-Kutta methods of order 4	2
	Tutorial	**1**
2.4	Predictor corrector methods	1
2.5	Adam's and Milne's predictor corrector formula	1
2.6	**Numerical Solution of PDEs:** Classification of Second order equation	1
	Tutorial	**1**
2.7	Solution to Elliptic PDEs	2
2.8	Solution to Parabolic PDEs	1
	Tutorial	**1**
3	**Complex Differentiation**	
3.1	**Complex Differentiation** Functions of complex variable	1
3.2	Analytic functions – C-R equations	2
	Tutorial	**1**
3.3	Conjugate harmonics	1
3.4	Standard Transformations	1
	Tutorial	**1**
3.5	Conformal Transformations – z^2, 1/z, az+b	2
3.6	Bilinear Transformations	2
	Tutorial	**1**
4	**Complex Integration**	
4.1	**Complex Integration:** Cauchy's Theorem and Cauchy's integral formula	2
4.2	Taylor's Series - Laurent's series	2

Module No.	Topic	No. of Periods
	Tutorial	**1**
4.3	Zeros of Analytic function and Singularities - Residues	1
4.4	Cauchy's residue theorem	2
	Tutorial	**1**
4.5	Contour Integration	3
	Total	48

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