LNMIIT, Jaipur Department of Mathematics	LNMIIT The LNM Institute of Information Technology

Programme: M.Sc. (Math.)	Course Title: Numerical Analysis and Scientific Computing			Course Code: MTH-4052
Type of Course: Core	Prerequisites: Calculus, Ordinary Differential Equations			Total Contact Hours: 40(L)+24(P)
Year/Semester: 1/Even	Lecture Hrs/Week: 3	Tutorial Hrs/Week: 0	Practical Hrs/Week: 2	Credits: 4

Learning Objective:

The main objective of this course is to introduce the students with the broad range and development of numerical methods for solving mathematical problems arises in science and engineering. The goal is to provide a basic understanding of the derivation, analysis and use of these numerical methods along with a rudimentary understanding of finite precision arithmetic. An important component of numerical analysis is computational implementation of algorithms which are developed in the course in order to observe first hand the issues of accuracy, computational work effort, and stability. Exercises will include computational experiments in MATLAB.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		Bloom's Level
CO-1	**Identify** the use of numerical methods in modern scientific computing	2
CO-2	**Understand** with finite precision computation and the importance of it in real life problems.	2
CO-3	**Develop** the basic understanding of the construction of numerical algorithms, and more importantly, the **applicability** and limits of their appropriate use for physical problems.	5
CO-4	**Analyze** the efficiency and stability of various numerical algorithms.	4
CO-5	**Analyze** the calculation and interpretation of errors in numerical methods.	4

Course Topics	Lecture Hours	
UNIT – I (Preliminaries of Scientific Computing & Root Finding Techniques)	**8**	**8**
1.1 Approximations in Scientific computing, Error propagation and amplification, conditioning, stability and accuracy, computer arithmetic.	3	
1.2 Bisection, Secant, False–position, Newton's methods, Muller's methods,	2	
1.3 Fixed point iteration method, Order of convergence, Newton's method for multiple roots, Error Analysis	3	
UNIT – II (System of Linear/Non-linear Equations, Eigenvalue Problem)	**8**	**8**
2.1 Linear Algebra review, Gaussian elimination, Pivoting, Gauss Elimination as LU Factorization, Cholesky Factorization, Pathology in linear systems-singular matrices, Determinants and matrix inversions,	**3**	
2.2 Norms, Condition numbers and error analysis; Stability, Iterative methods: Jacobi and Gauss-Seidel method and Newton's and fixed-point method of non-linear systems	**3**	
2.3 Eigen Values, Power method, Inverse power method, QR methods of finding eigenvalues and eigenvectors of matrices	**2**	
UNIT – III (Interpolation & Curve fitting)	**8**	**8**
3.1 Existence and uniqueness of interpolating polynomial, Lagrange polynomials	3	
3.2 Divided differences, Evenly spaced points, Error of interpolation,	2	
3.3 Piecewise interpolation, Extrapolation, Cubic spline, Least-Square approximations	3	

UNIT-IV (Numerical Differentiation & Integration)	**8**	**8**
4.1 Numerical differentiation, Richardson Extrapolation,	**2**	
4.2 Newton-Cotes integration formulas, Composite rules, Error terms for Newton-Cotes formulas and composite rules,	**3**	
4.3 Integration with Unequal Segments, Other ways to derive integration formulas, Romberg Integration, Quadrature rule, Gaussian quadrature.	**3**	
UNIT-V (Numerical Solution of IVP & BVP)	**8**	8
5.1 Taylor series method, Euler and Modified Euler's method, Runge-Kutta methods; Multistep methods: Milne's method, Adams-Moulton method,	**3**	
5.2 System of equations and Higher order equations, Stiff equations.	**2**	
5.3 Finite difference method for BVP, Shooting method, Solution through a set of equations, Derivatives boundary conditions.	**3**	
UNIT-VI (Scientific Computing Lab)	**24**	
Implementation of algorithms discussed in other units through MATLAB		**24**

Textbook References:

Text Book:

1. Numerical Analysis, *Richard L. Burden and J. Douglas Faires.*
2. Elementary Numerical Analysis: An Algorithmic Approach, *S. D. Conte, C. d. Boor, 3rd edition, McGraw-Hill International Editions.*
3. Scientific Computing - An introductory Survey, *M Heath*.

Reference books:

1. A friendly introduction to Numerical Analysis, *Brian Bradie, Pearson Education, 2007.*

2. Applied Numerical Methods with MATLAB for Engineers and Scientists. *Steve C Chapra, McGraw-Hill Science Engineering.*
3. In Introduction to Numerical Analysis, *K. F. Atkinson.*
4. *Numerical Analysis:* David Kincaid and Ward Cheney, Mathematics of Scientific Computing, (2002)

Additional Resources:

Evaluation Method	
Item	**Weightage (%)**
Assignments/Quiz	20
Midterm	20
End-Term	35
LAB	25

*Please note, as per the existing institute's attendance policy the student should have a minimum of 75% attendance. Students who fail to attend a minimum of 75% lectures will be debarred from the End Term/Final/Comprehensive examination.

CO and PO Correlation Matrix

CO	PO 1	PO 2	PO3	PO 4	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	
CO2	1	1	1	1	1	2	1
CO3	1	2	1	3	3	1	1
CO4	1	1		2	2	1	1
CO5	1		1	3	2		1

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Updated By:

Approved By: