Syllabus for Semester II (1446-1447 H)

An Introduction to Numerical Methods and Analysis Using MATLAB

Chapters	Sections	subsections	Sub-subsections	Covered in Lecture	
				Female section	Male Section
1 Introduction to Numerical Methods	1.1 Introduction	1.1.0.1 Types of Numerical Methods		✓	✓
	1.2 Error Analysis	1.2.0.1 What is Error		✓	✓
	1.3 Sources of Errors	1.3.1 Human Error		✓	✓
		1.3.2 Truncation Error		✓	✓
		1.3.3 Round-off Error		✓	✓
2 Solution of Nonlinear Equations	2.1 Introduction	2.1.0.1 Location of Roots		✓	✓
		2.1.0.2 Graphical Method		✓	✓
		2.1.0.3 Method of Tabulation		✓	✓
		2.1.0.4 A Trial Method for Tabulation		✓	✓
		2.1.0.5 A Systematic Process for Tabulation		✓	✓
		2.1.0.6 Types of Roots of a Nonlinear Equation		✓	✓
	2.2 Approximation of Simple Root of a Nonlinear Equation	2.2.1 Bisection Method		✓	✓
		2.2.2 Fixed-Point Method		✓	✓
		2.2.3 Newton's Method		✓	✓
		2.2.4 Secant Method		✓	✓
	2.3 Approximation of Multiple Root of	2.3.0.1 Multiplicity of a Multiple Root		✓	✓
		2.3.1 First Modified Newton's Method		✓	✓

	a Nonlinear Equation	2.3.2 Second Modified Newton's Method		✓	✓
		2.3.2.1 Problems with Multiple Roots		✓	✓
	2.4 Convergence of Iterative Methods	Order of convergence	Tell only order (without proof) and gives examples	✓	✓
		2.4.1 Convergence of Bisection Method		✓	✓
		2.4.2 Convergence of Fixed-point Method		✓	✓
		2.4.3 Convergence of Newton's Method		✓	✓
		2.4.4 Convergence of Secant Method		✓	✓
	2.5 Systems of Nonlinear Equations	2.5.1 Newton's Method for Solving Nonlinear System (of 2 equations only)		✓	✓
3 Systems of Linear Algebraic Equations	3.1 Introduction			Students Done in M-107 + M-244	Students
	3.2 Properties of Matrices and Determinant				Done in
	3.3 Solutions of Linear Systems of Equations				M-107 + M-244
	3.4 Direct Numerical Methods for Solving Linear Systems	3.4.1 Gaussian Elimination Method	3.4.1.1 Simple Gaussian Elimination Method (or Without Pivoting)	✓	✓
			3.4.1.2 Inverse of a Matrix by Simple Gaussian Elimination Method	✓	✓
			3.4.1.3 Pivoting Strategies Using Gaussian Elimination Method	✓	✓
			3.4.1.4 Partial Pivoting	✓	✓
			3.4.1.5 Inverse of a Matrix by Gauss Elimination with Partial Pivoting	✓	✓
		3.4.2 Gauss-Jordan Method	(**Discuss only to find inverse of a matrix**)	No	No
		3.4.3 LU Decomposition Method	3.4.3.1 Doolittle's Method	✓	✓

			3.4.3.2 Inverse of a Matrix by using Doolittle's Method	No	No
			3.4.3.3 Crout's Method	✓	✓
			3.4.3.4 Inverse of a Matrix by using Crout's Method	No	No
	3.5 Norms of Vectors and Matrices	3.5.1 Vector Norms	l-∞ norm only	✓	✓
		3.5.2 Matrix Norms	l-∞ norm only	✓	✓
	3.6 Iterative Methods for Solving Linear Systems	3.6.1 Jacobi Iterative Method		✓	✓
		3.6.2 Gauss-Seidel Iterative Method		✓	✓
		3.6.3 Matrix Forms of Iterative Methods for a Linear System	3.6.3.1 Jacobi Iterative Method	✓	✓
			3.6.3.2 Gauss-Seidel Iterative Method	✓	✓
		3.6.4 Convergence Criteria of Iterative Methods		✓	✓
	3.7 Errors in Solving Linear Systems	3.7.1 Ill-Conditioned Linear Systems		✓	✓
		3.7.2 Method to Solve Ill-Conditioned System		No	No
4 Polynomial Interpolation and Approximation	4.1 Introduction			✓	✓
	4.2 Polynomial Interpolation	4.2.1 Lagrange Interpolating Polynomials	4.2.1.1 Linear Lagrange Interpolating Polynomial	✓	✓
			4.2.1.2 Quadratic Lagrange Interpolating Polynomial	✓	✓
			4.2.1.3 Cubic Lagrange Interpolating Polynomial	✓	✓
			4.2.1.4 Nth Degree Lagrange Interpolating Polynomial	✓	✓
			4.2.1.5 Uniqueness of Lagrange Interpolating Polynomial	✓	✓
			4.2.1.6 Error Formula of Lagrange Polynomial	✓	✓
			4.2.2.1 Divided Differences of a Function	✓	✓

		4.2.2 Newton's General Interpolating Formula	4.2.2.2 Linear Newton's Interpolating Polynomial	✓	✓
			4.2.2.3 Quadratic Newton's Interpolating Polynomial	✓	✓
			4.2.2.4 Cubic Newton's Interpolating Polynomial	✓	✓
			4.2.2.5 Nth Degree Newton's Interpolating Polynomial	✓	✓
			4.2.2.6 Newton's Interpolation at Repeated Data Points	✓	✓
	4.3 Interpolation with Spline Functions	4.3.1 Piecewise Linear Interpolation		✓	✓
5 Numerical Differentiation and Integration	5.1 Introduction			✓	✓
	5.2 Numerical Differentiation			✓	✓
	5.3 Numerical Differentiation Formulas	5.3.0 Differentiation of the Lagrange Polynomial		✓	✓
		5.3.1 First Derivative Numerical Formulas	5.3.1.1 Two-point Formula	✓	✓
			5.3.1.2 Error Term and Error Bound of Two-point Formula	✓	✓
			5.3.1.3 Three-point Central Difference Formula	✓	✓
			5.3.1.4 Error Formula and Error Bound Formula of Central Difference Formula	✓	✓
			5.3.1.5 Three-point Forward and Backward Difference Formulas with Error Formulas	✓	✓
		5.3.2 Second Derivative Numerical Formula	5.3.2.1 Three-point Central Difference Formula	✓	✓
			5.3.2.2 Error Bound for Three Point Central Difference Formula	✓	✓
	5.4 Numerical Integration				

	5.5 Closed Newton-Cotes Formulas	5.5.1 Trapezoidal Rule	5.5.1.1 Simple Trapezoidal Rule	✓	✓
			5.5.1.2 Composite Trapezoidal Rule	✓	✓
			5.5.1.3 Error Terms for Trapezoidal Rule	✓	✓
			5.5.1.4 Error Bound for Simple Trapezoidal Rule	✓	✓
			5.5.1.5 Error Term for Composite Trapezoidal Rule	✓	✓
			5.5.1.6 Error Bound for Composite Trapezoidal Rule	✓	✓
		5.5.2 Simpson's Rule	5.5.2.1 Simple Simpson's Rule	✓	✓
			5.5.2.2 Error Terms for Simpson's Rule	✓	✓
			5.5.2.3 Error Bound for Simple Simpson's Rule	✓	✓
			5.5.2.4 Composite Simpson's Rule	✓	✓
			5.5.2.5 Error Term for Composite Simpson's Rule	✓	✓
			5.5.2.6 Error Bound for Composite Simpson's Rule	✓	✓
6 Numerical Solution of Ordinary Differential Equations	6.1 Introduction			✓	✓
	6.2 Ordinary Differential Equations			✓	✓
		6.2.1 Classification of Differential Equations		✓	✓
	6.3 Numerical Methods for Solving Differential Equations			✓	✓
		6.3.1 Euler's Method		✓	✓
			6.3.1.1 Analysis of the Euler's Method	No	No
		6.3.2 Higher-Order Taylor Methods		✓	✓
		6.3.3 Second-Order Runge-Kutta Method		✓	✓
			6.3.3.1 Modified Euler's Method	✓	✓

About the 10 Tutorial Marks

1. Attendance in Tutorial Class = 2 Marks
2. Computer Assignment = 2 Marks
3. Two Quizzes = 6 Marks

Computer Assignment

Write a computer program of the **Modified Newton's Method** for nonlinear equation (Chapter 2)

Dates of Midterm and Final Examinations

1. First Midterm Exam: 25 Marks Tuesday: 19-08-1446(18-02-2025) Time: 4:45 - 6:15 PM
2. Second Midterm Exam: 25 Marks Tuesday: 17-10-1446(15-04-2025) Time: 4:45 - 6:15 PM
3. Final Exam: 40 Marks Monday: 14-11-1446(12-05-2025) Time: 1:00 - 4:00 PM

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