MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	Marthoma College, Kuttapuzha P.O, Tiruvalla					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Roshan Sara Philipose					
Contributors	Dr Roshan Sara Philipose, Mrs Anu Ann James					
Course Name	Numerical Methods for Scientific Computing					
Type of Course	DSE					
Specialization title	Computational Mathematics					
Course Code	MG3DSEMATA02					
Course Level	200					
Course Summary	This course introduces computational methods and algorithmic solution of mathematical problems that occur in scientific applications. The course presents the fundamental concepts required to perform meaningful numerical computation and serves as the foundation for advanced courses on algorithms and computational linear algebra.					
Semester	3	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Calculus, Programming Fundamentals, Introductory Linear Algebra					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand sources and behavior of error in computation	U	PO1, PO2, PO10
2	Solve equations and systems numerically	A	PO1, PO2, PO3, PO10
3	Construct interpolating and approximating functions	A	PO1, PO2, PO3, PO10
4	Apply integration and differentiation techniques numerically	A	PO1, PO2, PO3, PO10
5	Apply numerical methods to differential equations	AN	PO1, PO2, PO3, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	-	-	-	-	-	-	-	1
CO 2	3	3	1	-	-	-	-	-	-	2
CO 3	2	2	1	-	-	-	-	-	-	1
CO 4	2	2	1	-	-	-	-	-	-	1
CO 5	2	3	1	-	-	-	-	-	-	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Foundations of Scientific Computing			
	1.1	Introduction, Computer Arithmetic	3	["1"]
	1.2	Errors	3	["1"]
	1.3	Machine Computation, Computer Software	4	["1"]
2	Numerical Methods for Equations			
	2.1	Introduction to transcendental and polynomial equations, Bisection method, Iteration method based on first degree equation – Newton Raphson Method	6	["2"]
	2.2	Introduction to system of Linear Algebraic Equations, Direct Methods: Gaussian elimination, Triangularization Method (LU decomposition)	6	["2"]
	2.3	Iterative methods: Jacobi Iteration method, Gauss-Seidel Iteration method	6	["2"]
3	Interpolation and Approximation Techniques			
	3.1	Lagrange and Newton interpolations	4	["3"]
	3.2	Piecewise and Spline Interpolation	5	["3"]
	3.3	Least squares approximation	5	["3"]
4	Numerical Calculus and Differential Equations			
	4.1	Numerical differentiation -Methods based on interpolation	6	["4", "5"]
	4.2	Numerical integration, Methods Based on Interpolation: Determination of the Error Term, Newton-Cotes Methods	6	["4", "5"]
	4.3	Ordinary Differential Equations: Introduction, Initial Value Problem, Numerical Methods – Euler method, Singlestep Methods - Runge-Kutta methods	6	["4", "5"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom Procedure (Mode of transaction) Lectures, Interactive problem-solving, Assignments, Presentations.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests (I– IV): 20 Marks Assignment: 5 Marks Quiz: 5 Marks **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Test Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ Short answer - (5 out of 8) – 5 × 2 = 10 ∘ PART - B ∘ Short Essays/Problems - (5 out of 8) – 5 × 6 = 30 ∘ PART - C ∘ Essays - (3 out of 6) – 3 × 10 = 30

References

- Jain, Mahinder Kumar. Numerical Methods for Scientific and Engineering Computation. 6th ed., New Age International, 2012.

Suggested Readings

- Chapra, Steven C., and Raymond P. Canale. Numerical methods for engineers. Vol. 1221. New York: Mcgraw-hill, 2011.
- Burden, Richard L., Douglas J. Faires, and Anette M. Burden. Numerical Analysis. 10th ed., Cengage Learning, 2014.
- Atkinson, Kendall E. An introduction to numerical analysis. John wiley & sons, 2008.
- Hildebrand, Francis Begnaud. Introduction to numerical analysis. Courier Corporation, 1987.

Affidavit

- We, Marthoma College, Kuttapuzha P.O, Tiruvalla and Dr. Roshan Sara Philipose, agree to permit the use of our proposed course syllabus by other faculty members within the same discipline for course delivery at their respective institutions.
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SYLLABUS						
SIGNATURE COURSE						
Name of the College	Marthoma College, Kuttapuzha P.O, Tiruvalla					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Roshan Sara Philipose					
Contributors	Dr Roshan Sara Philipose, Anu Ann James					
Course Name	Computational Methods for Optimization					
Type of Course	DSE					
Specialization title	Computational Mathematics					
Course Code	MG4DSEMATA02					
Course Level	200					
Course Summary	This course provides a foundation in optimization techniques, covering problem formulation, classical and numerical methods, and linear programming. It emphasizes both theoretical understanding and practical implementation using MATLAB to solve real-world optimization problems					
Semester	4	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Calculus, Linear Algebra, and Basic Numerical Methods, along with introductory programming experience in MATLAB					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand the fundamental concepts, structure, and classifications of optimization problems.	U	PO1, PO2, PO3, PO10
2	Apply classical techniques to solve single and multivariable optimization problems with and without constraints using analytical methods	A, AN	PO1, PO2, PO3, PO10
3	Apply the simplex and dual simplex methods to solve linear programming problems and analyze primal–dual relationships.	A, AN	PO1, PO2, PO3, PO4, PO10
4	Implement and compare unconstrained numerical optimization methods for one-dimensional and multivariable problems.	A, E	PO1, PO2, PO3, PO4, PO5, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	1	-	-	-	-	-	-	1
CO 2	3	3	1	-	-	-	-	-	-	2
CO 3	3	3	2	1	-	-	-	-	-	2
CO 4	2	3	2	1	1	-	-	-	-	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Introduction to Optimization			
	1.1	Introduction	3	["1"]
	1.2	Statement of an Optimization Problem	3	["1"]
	1.3	Classification of Optimization Problems - Classification Based on the Existence of Constraints, Classification Based on the Nature of the Design Variables, Classification Based on the Physical Structure of the Problem	4	["1"]
2	Classical Optimization Techniques			
	2.1	Single-Variable Optimization	5	["2"]
	2.2	Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints - Solution by the Method of Lagrange Multipliers	5	["2"]
	2.3	Multivariable Optimization with Inequality Constraints - Kuhn–Tucker Conditions	6	["2"]
3	Linear Programming and the Simplex Method			
	3.1	Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems	6	["3"]
	3.2	Definitions and Theorems, Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations Simplex Algorithm, Identifying an Optimal Point, Improving a Nonoptimal Basic Feasible Solution, Two Phases of the Simplex Method	6	["3"]
	3.3	Revised Simplex Method, Duality in Linear Programming, Symmetric Primal–Dual Relations, General Primal–Dual Relations, Primal–Dual Relations, Duality Theorems, Dual Simplex Method	6	["3"]

Module	Units	Course Description	Hrs	CO No.
4	Unconstrained Numerical Optimization			
	4.1	Introduction, unimodal functions	4	["4"]
	4.2	Univariate Search Methods - Exhaustive Search, Dichotomous Search, Interval Halving, Fibonacci and Golden Section Methods	6	["4"]
	4.3	Gradient-Based Methods for Multivariable Problems: Steepest Descent Method, Newton's Method	6	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom Procedure (Mode of transaction) Lectures, derivation and analysis of methods, lab sessions using MATLAB

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests (I– IV): 20 Marks Assignment: 5 Marks Quiz: 5 Marks **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Test Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ Short answer - (5 out of 8) – 5 × 2 = 10 ∘ PART - B ∘ Short Essays/Problems - (5 out of 8) – 5 × 6 = 30 ∘ PART - C ∘ Essays - (3 out of 6) – 3 × 10 = 30

References

- Rao, Singiresu S. Engineering Optimization: Theory and Practice. 4th ed., Wiley, 2009.

Suggested Readings

- Himmelblau, David M. Applied nonlinear programming. McGraw-Hill, 2018.
- Nocedal, Jorge, and Stephen J. Wright, eds. Numerical optimization. New York, NY: Springer New York, 1999.
- Chapra, Steven C. Applied numerical methods with MATLAB for engineers and scientists. McGraw-Hill, 2018.
- Kiusalaas, Jaan. Numerical Methods in Engineering with MATLAB. Cambridge University Press, 2010.

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2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	Marthoma College, Kuttapuzha P.O, Tiruvalla					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Roshan Sara Philipose					
Contributors	MR MANESH JACOB					
Course Name	Design and Analysis of Algorithms					
Type of Course	DSE					
Specialization title	Computational Mathematics					
Course Code	MG5DSEMATA02					
Course Level	300					
Course Summary	This course introduces fundamental concepts in the design and analysis of algorithms. It equips students to analyze algorithm efficiency using time and space complexity, prove correctness using formal techniques, and design algorithms for a wide range of computational problems. The course emphasizes algorithmic paradigms such as divide-and-conquer, greedy methods, dynamic programming, and graph algorithms. Students will explore computational complexity theory and classify problems based on their solvability and efficiency.					
Semester	5	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Analyze the efficiency of algorithms using time and space complexity	AN	PO1, PO2, PO3
2	Design algorithms for a variety of computational problems	C	PO1, PO2, PO3, PO4
3	Prove correctness of algorithms using inductive proofs and invariants	U	PO1, PO2, PO3, PO9
4	Identify and apply suitable algorithmic design techniques for specific problems	AN	PO1, PO2, PO4, PO10
5	Investigate computational complexity and classify problems based on their computational difficulty	E	PO1, PO2, PO10
6	Analyze and explain major algorithm paradigms.	A	PO1, PO2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	1	-	-	-	-	-	-	-
CO 2	3	3	2	1	-	-	-	-	-	-
CO 3	3	2	1	-	-	-	-	-	1	-
CO 4	3	3	-	1	-	-	-	-	-	2
CO 5	3	3	-	-	-	-	-	-	-	2
CO 6	3	3	-	-	-	-	-	-	-	-

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Basics of Algorithm Analysis			
	1.1	Big O notation — sorting and searching — algorithm analysis techniques	5	["1"]
	1.2	Graph Algorithms 5	5	["1", "2"]
	1.3	Network Flow	5	["1", "2"]
2	Greedy Algorithms			
	2.1	Scheduling	8	["3"]
	2.2	Divide and conquer	7	["3"]
3	Dynamic Programming			
	3.1	Weighted interval Scheduling, Principles of dynamic programming	5	["4"]
	3.2	Segmented Least Squares, Subset Sums and Knapsacks	5	["4"]
	3.3	Linear programming algorithms and applications	5	["4"]
4	NP and Computational Intractability			
	4.1	Polynomial Time Reductions	7	["5", "6"]
	4.2	NP- Complete Problems	8	["5", "6"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Conceptual Lectures, Worked Examples & Problem Solving, Interactive Discussions, Tutorials and Assignments

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Test, Seminar, Course Portfolio **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – TEST Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ Short answer - (5 out of 8) – 5 × 2 = 10 ∘ PART - B ∘ Short Essays/Problems - (5 out of 8) – 5 × 6 = 30 ∘ PART - C ∘ Essays - (3 out of 6) – 3 × 10 = 30

References

- J. Kleinberg and E. Tardos: Algorithm design, Pearson/Addison-Welsey (2006).
- T.H. Cormen, C.E. Leiserson, R.L. Rivest and Clifford Stein: Introduction to algorithms, 3rd Edition MIT Press 2009

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SYLLABUS						
SIGNATURE COURSE						
Name of the College	Marthoma College, Kuttapuzha P.O, Tiruvalla					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Roshan Sara Philipose					
Contributors	MANESH JACOB					
Course Name	Computational Linear Algebra					
Type of Course	DSE					
Specialization title	Computational Mathematics					
Course Code	MG6DSEMATA02					
Course Level	300					
Course Summary	This course introduces numerical and algorithmic approaches to solving linear algebra problems arising in scientific and engineering contexts. It covers techniques for solving linear systems, evaluating numerical accuracy and stability, and applying matrix factorization methods. Students will develop and implement algorithms using scientific programming languages and design computational strategies for handling high-dimensional data. Emphasis is placed on practical application and problem-solving using modern computational linear algebra tools.					
Semester	6	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Analyze and apply numerical methods for solving linear systems	AN	PO1, PO2, PO3
2	Evaluate accuracy, Conditioning and numerical stability in computational problems	E	PO1, PO2, PO3, PO4
3	Use matrix factorization techniques in various situations	A	PO1, PO2, PO3, PO9
4	Prepare suitable linear algebra algorithms for specific problems using scientific programming languages.	AN	PO1, PO2, PO4, PO10
5	Design computational strategies for problems involving high dimensional matrices	E	PO1, PO2, PO10

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
6	Apply computational Linear Algebra tools to solve problems in science and engineering	A	PO1, PO2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	-	-	-	-	-	-	-
CO 2	3	3	1	1	-	-	-	-	-	-
CO 3	3	2	2	-	-	-	-	-	1	-
CO 4	2	3	-	2	-	-	-	-	-	3
CO 5	3	3	-	-	-	-	-	-	-	1
CO 6	3	3	-	-	-	-	-	-	-	-

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Matrix Operations			
	1.1	Matrix Multiplication	4	["1"]
	1.2	Norm of vectors	4	["1"]
	1.3	Basic problems in Machine Learning and Neural Networks	7	["1"]
2	Factorization of Matrices and Applications			
	2.1	LU Decomposition and Applications	5	["2", "3"]
	2.2	QR Decomposition	5	["2", "3"]
	2.3	Gram-Schmidt Orthogonalization	5	["2", "3"]
3	Eigen Values and Factorizations			
	3.1	Diagonalization of matrices	5	["3"]
	3.2	Eigen value Algorithms	5	["4"]
	3.3	Machine Learning and Optimization Applications of eigen values and eigen vectors	5	["4"]
4	Singular Value Decomposition			
	4.1	Singular Value Decomposition of Square and Rectangular Matrices	5	["1", "5", "6"]
	4.2	Truncated Singular Value Decomposition	5	["6"]
	4.3	Basic problems in Machine Learning and Neural Networks	5	["5", "6"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Conceptual Lectures, Problem Solving, Interactive Discussions, Tutorials

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Tests, Seminar, Course Portfolio **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Test Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ Short answer - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short Essays/Problems - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

References

- Charu C. Aggarval : Linear Algebra and Optimization for Machine Learning, Springer 2020.
- Lloyed N. Trefethen and David Bau : Numerical Linear Algebra (III)
- Gilbert Strang: Linear Algebra and Learning from Data, Wellesley-Cambridge Press

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