Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for B.Sc. (Computer Science) Mathematics

F. Y. B. Sc. (Computer Science) Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
I	CSMT1101	Graph Theory	2
	CSMT1102	Algebra	2
	CSMT1103	Mathematics Practical based on CSMT1101 & CSMT1102	2
II	CSMT1201	Discrete Mathematics	2
	CSMT1202	Calculus	2
	CSMT1203	Mathematics Practical based on CSMT1201 & CSMT1202	2

S. Y. B. Sc. (Computer Science) Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
III	CSMT2301	Linear Algebra	3
	CSMT2302	Numerical Analysis	3
	CSMT2303	Mathematics Practical I	2
IV	CSMT2401	Computational Geometry	3
	CSMT2402	Operations Research	3
	CSMT2403	Mathematics Practical II	2

Choice Based Credit System Syllabus (2019 Pattern)

Class: S.Y.B.Sc.(Computer Science). (Sem III) **Subject:** Mathematics
Course: Applied Algebra **Course Code:** CSMT2301

A. Course Objectives:

1. Student will able to understand the fundamental concepts of vector spaces and their applications.
2. Learn about subsets of vector spaces that retain vector space properties.
3. Understand the diagonalization of matrices using eigenvalues and eigenvectors.
4. Study the concept of inverse linear transformations.
5. Learn how to represent linear transformations using matrices.
6. Understand the notions of angle and Orthogonality in inner product spaces.
7. Learn the Gram-Schmidt process for orthogonalizing a set of vector

B. Course Outcome:

1. Student will apply the principles of Euclidean n-space, including geometric interpretations and applications.
2. Recognize and apply the concept of linear independence in vector spaces.
3. Analyze and understand the row space, column space, and null space of matrices, and relate them to linear transformations.
4. Apply techniques for determining eigenvalues and eigenvectors of matrices.
5. Apply the concept of inverse linear transformations and recognize their importance in various applications.
6. Analyze and calculate the kernel and range of linear transformations.
7. Apply inner products to analyze angles and Orthogonality in inner product spaces.

Topics/Contents:

Unit 1- General Vector Spaces: [14 lectures]

- Real Vector Spaces, Euclidean n-Space.
- Subspaces of a Vector Space.
- Linear Combination and Linear Span, Linear Independence, Basis and Dimension.
- Row Space, Column Space, Null Space.
- Rank and Nullity.

Unit 2- Eigen Values and Eigen Vectors: [12 lectures]

- Eigen Values and Eigen Vectors, Diagonalization.
- Quadratic Forms.

Unit 3- Linear Transformations: [16 lectures]

- Linear Transformation.
- Kernel and Range of a Linear Transformation.
- Inverse Linear Transformation.
- Matrix of General Linear Transformation.

Unit 4-Inner Product Spaces: [6 lectures]

- Inner Products.
- Angle and Orthogonality in Inner Product Spaces.
- Gram-Schmidt Process.

Text Book: H. Anton and C. Rorres, Elementary Linear Algebra with Applications, Eleventh Ed. Wiley, (1994). Sections : 4.1 to 4.8, 5.1 to 5.2, 7.3, 6.1 to 6.3, 8.1 to 8.4

Reference Books:(1) M. Artin, Algebra, Prentice Hall of India , New Delhi, (1994).
(3) K. Hoffmann and R. Kunze Linear Algebra, Second Ed. Prentice Hall of India
(4) S. Lang, Introduction to Linear Algebra, Second Ed. Springer-Verlag
(5) A. Ramchandra Rao and P. Bhimasankaran, Linear Algebra, Tata McGraw Hill,
(6) Discrete Mathematics Structures (sixth edition), Kloman, Busby and Ross. PHI.
(7) G. Strang, Linear Algebra and its Applications. Third Ed. Harcourt Brace Jovanovich
(8) S. Kumaresan , Linear Algebra: A Geometric Approach, Prentice Hall of India

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or directrelation

	Programme Outcomes (POs)						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2			3	3
CO 2			1			3	
CO 3			3			2	2
CO 4		3	2			3	
CO 5		2				3	1
CO 6		2	3			2	
CO 7		1	2				3

Justification for the mapping

PO2: Design / Development of solution

CO4: Applying techniques for determining eigenvalues and eigenvectors in the design/development of a solution enables efficient linear transformation analysis, facilitating

optimal system stability and performance optimization through eigen-based feature extraction and dimensionality reduction.
CO5: Applying the concept of inverse linear transformations is crucial in design and development, allowing for the effective solution of inverse problems, system calibration, and the reconstruction of original data, enhancing versatility in diverse applications such as image processing, signal recovery, and optimization.
CO6: Analyzing and calculating the kernel and range of linear transformations in the design/development of a solution provides insights into solution space, aiding in system optimization and constraint identification for enhanced problem-solving efficiency.
CO7: Applying inner products to analyze angles and orthogonality in inner product spaces during the design/development of a solution ensures precise vector alignment and efficient orthogonal decomposition, enhancing numerical stability and geometric understanding for optimal problem-solving strategies.

PO3: Modern tool usage
CO1: Student will apply the principles of Euclidean n-space, incorporating geometric interpretations and modern tool applications, fostering a comprehensive understanding that underpins practical problem-solving and analytical skills in diverse fields.
CO2: Student will recognize and apply the concept of linear independence in vector spaces within modern tools, enabling them to enhance computational efficiency, numerical stability, and analytical precision in various applications.
CO3: Student will analyze and understand the row space, column space, and null space of matrices, and relate them to linear transformations in modern tool uses, fostering a deep comprehension of linear algebra concepts essential for effective problem-solving and system analysis.
CO4: Student will apply techniques for determining eigenvalues and eigenvectors of matrices in modern tool uses, enhancing their ability to analyze dynamic systems, extract key features, and optimize solutions in diverse computational applications.
CO6: Student will analyze and calculate the kernel and range of linear transformations in modern tool uses, equipping them with essential skills to optimize system solutions, identify constraints, and enhance computational efficiency across a variety of applications.
CO7: Student will apply inner products to analyze angles and orthogonality in inner product spaces in modern tool uses, providing a foundation for precise vector manipulation,

optimization, and geometric understanding in diverse computational applications.

PO6: Individual and Team work

CO1: Student will apply the principles of Euclidean n-space, integrating geometric interpretations and applications, fostering individual and teamwork skills essential for collaborative problem-solving and innovative solutions across diverse domains.
CO2: Student will recognize and apply the concept of linear independence in vector spaces, cultivating essential skills for both individual and teamwork scenarios, promoting collaborative problem-solving and effective communication in diverse applications.
CO3: Student will analyze and understand the row space, column space, and null space of matrices, and relate them to linear transformations, fostering a foundation for individual and teamwork problem-solving, system analysis, and efficient communication in diverse applications.
CO4: Student will apply techniques for determining eigen values and eigenvectors of matrices, enhancing individual and teamwork problem-solving capabilities, and enabling efficient analysis and optimization of systems across diverse collaborative applications.

CO5: Student will apply the concept of inverse linear transformations, recognizing their significance in various applications, thereby fostering individual and teamwork problem-solving skills essential for system calibration, data recovery, and optimization in collaborative projects.
CO6: Student will analyze and calculate the kernel and range of linear transformations, fostering individual and teamwork skills crucial for efficient problem-solving, system optimization, and collaborative decision-making across a range of applications.

PO7: Innovation, employability and Entrepreneurial skills
CO1: Student will apply the principles of Euclidean n-space, incorporating geometric interpretations and applications, to develop innovation, employability, and entrepreneurial skills, fostering a practical understanding essential for creative problem-solving in diverse contexts.

CO3: Student will analyze and understand the row space, column space, and null space of matrices, relating them to linear transformations, to enhance innovation, employability, and entrepreneurial skills, enabling practical problem-solving and strategic thinking in various professional contexts.

CO5: Student will apply the concept of inverse linear transformations, recognizing their importance in various applications, to cultivate innovation, employability, and entrepreneurial skills, empowering them with a versatile problem-solving toolkit for dynamic and creative solutions in diverse professional settings.

CO7: Student applying inner products to analyze angles and orthogonality in inner product spaces enhance innovation, employability, and entrepreneurial skills, fostering a practical foundation for precise measurements, optimization, and creative problem-solving in diverse professional contexts.

Choice Based Credit System Syllabus (2019 Pattern)

Class: S.Y.B.Sc.(Computer Science). (Sem III) **Subject:** Mathematics
Course: Numerical Analysis **Course Code:** CSMT2302

A. Course Objectives:

1. Study the various types of errors that can occur in numerical calculations.
2. Implement Euler's Method for the numerical solution of ordinary differential equations.
3. Analyze the impact of errors on numerical results and develop strategies to minimize errors in computations.
4. Estimate errors using difference tables and develop techniques to determine missing terms.
5. Understand Lagrange's Interpolation Formula and its application.
6. Utilize the Newton-Raphson Method to find roots of equations, demonstrating an understanding of its strengths and limitations.
7. Apply general quadrature formulas for numerical integration.

B. Course Outcome:

1. Understand the significance of numerical accuracy and precision in computations.
2. Apply the False Position Method to solve algebraic equations and understand its convergence behavior.
3. Understand and apply forward, backward, and central differences in numerical calculations.
4. Apply Central Difference Formulae, including Gauss Forward and Backward Difference Formulas, and Bessel's Interpolation Formula.
5. Apply Simpson's One-Third Rule and Simpson's Three-Eight Rule for accurate numerical integration.
6. Apply divided differences and Newton's Divided Difference Formula for interpolating values.
7. Apply the Runge-Kutta Method for more accurate and efficient numerical solutions to ordinary differential equations.

Topics/Contents

Unit 1-Errors: [03 lectures]

- Accuracy of numbers.
- Errors.

Unit 2- Algebraic and Transcendental Equation. [06 lectures]

- False Position Method.
- Newton Raphson Method.

Unit 3-Calculus of Finite Differences: [10 lectures]

- Differences
- Fundamental Theorem of Differences of Polynomial.(without proof)
- Estimation of Error by Difference Table.
- Technique to determine the Missing Term.

Unit 4- Interpolation with Equal Interval. [10 lectures]

- Newton's Gregory Formula for Forward Interpolation.
- Newton's Gregory Formula for Backward Interpolation.
- Central Difference Formulae.

Unit 5-Interpolation with Unequal Interval. [08lectures]

- Lagrange's Interpolation Formula.
- Error in Lagrange's Interpolation Formula.
- Divided Difference.
- Newton's Divided Difference Formula.

Unit 6-Numerical Integration . [05 lectures]

- General Quadrature Formula.
- Trapezoidal Rule.
- Simpson's One –Third Rule, Simpson's Three –Eight Rule.

Unit 7- Numerical Solution of Ordinary Differential Equation. [06 lectures]

- Euler's Method.
- Rung -Kutta Method.

Text Book:

S.S Sastry , Introductory Methods of Numerical Analysis, 5th edition,
Prentice Hall of India, 1999 Sections: 1.3, 1.4, 2.3, 2.5, 3.3, 3.5, 3.6, 3.7(3.7.1, 3.7.3), 3.10, 3.9(3.9.1)6.4, 8.4, 8.5

Reference Books:

1) H.C. Saxena; Finite differences and Numerical Analysis, S. Chand
2) K.E. Atkinson ; An Introduction to Numerical Analysis, Wiley Publications.
3) Balguruswamy; Numerical Analysis.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or directrelation

	Programme Outcomes (POs)						
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		2	3			3	
CO 2			2			3	3
CO 3	3		3			3	
CO 4			3			3	3
CO 5			3			3	2
CO 6			3			2	2
CO 7	2		1			3	

Justification for the mapping

PO1: Computer Knowledge

CO3: Student understanding and applying forward, backward, and central differences in numerical calculations acquire essential skills in computer knowledge, enabling them to develop robust algorithms, optimize computational efficiency, and solve real-world problems with precision.

CO7: Student applying the Runge-Kutta Method for more accurate and efficient numerical solutions to ordinary differential equations in computer knowledge acquire a critical skill set, enhancing their ability to model dynamic systems, simulate real-world scenarios, and optimize computational accuracy in various applications.

PO2: Design / Development of solution

CO1: Student understanding the significance of numerical accuracy and precision in computations during the design/development of solutions gain a foundational awareness critical for ensuring reliable and robust algorithms, minimizing errors, and optimizing the performance of computational solutions.

PO3: Modern tool usage

CO1: Student understanding the significance of numerical accuracy and precision in computations in modern tool uses develop a critical foundation for optimizing algorithms, minimizing errors, and ensuring the reliability of computational solutions across diverse applications.

CO2: Student applying the False Position Method to solve algebraic equations and understanding its convergence behavior in modern tool uses gain a valuable skill set, enabling efficient and reliable numerical solutions with insights into convergence characteristics for enhanced problem-solving.

CO3: Student understanding and applying forward, backward, and central differences in numerical calculations in modern tool uses acquire foundational skills essential for developing accurate algorithms, optimizing computational efficiency, and solving real-world problems with precision.

CO4: Student applying Central Difference Formulae, including Gauss Forward and Backward Difference Formulas, and Bessel's Interpolation Formula in modern tool uses, develop advanced numerical skills, facilitating precise data interpolation, algorithm optimization, and efficient problem-solving in diverse computational applications.

CO5: Student applying Simpson's One-Third Rule and Simpson's Three-Eight Rule for accurate numerical integration in modern tool uses develop advanced skills, ensuring precise calculation of definite integrals and enhancing computational accuracy in diverse applications.

CO6: Student applying divided differences and Newton's Divided Difference Formula for interpolating values in modern tool uses acquire crucial skills for accurate data interpolation, facilitating effective modeling and analysis in diverse computational applications.
CO7: Student applying the Runge-Kutta Method for more accurate and efficient numerical solutions to ordinary differential equations in modern tool uses acquire advanced computational skills, enabling precise modeling and simulation of dynamic systems across diverse applications.

PO6: Individual and Team work

CO1: Student understanding the significance of numerical accuracy and precision in individual and team work cultivate essential skills for collaborative problem-solving, effective communication, and reliable decision-making, ensuring the success of diverse projects and tasks.

CO2: Student applying the False Position Method to solve algebraic equations and understanding its convergence behavior in individual and team work acquire critical numerical skills, facilitating collaborative problem-solving and informed decision-making across a range of applications and projects.

CO3: Student understanding and applying forward, backward, and central differences in numerical calculations in individual and team work develop foundational skills, promoting effective collaboration, problem-solving, and optimization of computational methods across diverse projects and tasks.

CO4: Student applying Central Difference Formulae, including Gauss Forward and Backward Difference Formulas, and Bessel's Interpolation Formula in individual and team work, acquire advanced numerical skills, fostering collaborative problem-solving and efficient data interpolation across a variety of projects and tasks.

CO5: Student applying Simpson's One-Third Rule and Simpson's Three-Eight Rule for accurate numerical integration in individual and team work develop advanced skills, promoting collaborative problem-solving and precise calculations in diverse projects and tasks that involve numerical analysis.

CO6: Student applying divided differences and Newton's Divided Difference Formula for interpolating values in individual and team work acquire essential skills, fostering collaborative problem-solving and efficient data interpolation across various projects and tasks in diverse domains.

CO7: Students applying the Runge-Kutta Method for more accurate and efficient numerical solutions to ordinary differential equations in individual and team work gain advanced computational skills, enhancing collaborative problem-solving and enabling precise modeling of dynamic systems across diverse projects and tasks.

PO7: Innovation, employability and Entrepreneurial skills
CO2: Student applying the False Position Method to solve algebraic equations and understanding its convergence behavior foster innovation, employability, and entrepreneurial skills by gaining valuable numerical problem-solving abilities essential for addressing real-world challenges and optimizing solutions in various professional contexts.

CO4: Student applying Central Difference Formulae, including Gauss Forward and Backward Difference Formulas, and Bessel’s Interpolation Formula in innovation, employability, and entrepreneurial skills develop advanced computational capabilities,

enabling them to tackle complex problems, optimize algorithms, and contribute to innovative solutions in diverse professional settings.

CO5: Student applying Simpson’s One-Third Rule and Simpson’s Three-Eight Rule for accurate numerical integration in innovation, employability, and entrepreneurial skills develop advanced computational expertise, enhancing their ability to optimize algorithms, make informed decisions, and contribute to innovative solutions in various professional contexts.

CO6: Student applying divided differences and Newton’s Divided Difference Formula for interpolating values in innovation, employability, and entrepreneurial skills acquire crucial numerical abilities, enabling them to contribute to innovative solutions, optimize algorithms, and address real-world challenges in various professional contexts.

Choice Based Credit System Syllabus (2019 Pattern)

Class: S.Y.B.Sc.(Computer Science). (Sem III) **Subject:** Mathematics
Course: Mathematics Practical I **Course Code:** CSMT2303

A. Course Objectives:

1. Introduce students to Scilab, ensuring they are familiar with the software interface, basic commands, and its application in numerical computations.
2. Develop proficiency in performing basic operations on matrices using Scilab, including addition, multiplication, and inversion.
3. Teach students the Regula-Falsi and Newton-Raphson methods, enabling them to apply these techniques for finding roots of equations.
4. Instruct students on computing eigenvalues and eigenvectors using Scilab, and guide them through the process of diagonalization, ensuring a thorough understanding of these concepts.
5. Enable students to apply Newton's forward and backward interpolation formulas to interpolate values between data points, emphasizing practical applications.
6. Instruct students on the efficient use of Newton's backward interpolation formula and Newton's divided difference formula for interpolating values in various contexts.
7. Teach students the Trapezoidal Method, Simpson's (1/3)rd Rule, and Simpson's (3/8)th Rule for numerical integration using Scilab, ensuring they can accurately approximate definite integrals.

B. Course Outcome:

1. Students will demonstrate proficiency in using Scilab, including familiarity with the interface, executing basic commands, and navigating the software for numerical computations.
2. Students will perform basic operations on matrices using Scilab, including addition, multiplication, and inversion, developing a strong foundation for more complex numerical tasks.
3. Through practical exercises, students will apply the Regula-Falsi and Newton-Raphson methods to find roots of equations, gaining hands-on experience in solving algebraic and transcendental equations.
4. Students will compute eigenvalues and eigenvectors using Scilab, and demonstrate the process of diagonalization, fostering an understanding of these concepts and their applications.
5. Using Newton's forward and backward interpolation formulas, students will interpolate values between data points, gaining practical skills in approximating unknown values..
6. Students will apply Newton's backward interpolation formula and Newton's divided difference formula for interpolating values, understanding their efficiency and limitations in different scenarios..
7. Students will apply numerical methods to real-world problems, developing the ability to choose appropriate methods for specific computational tasks and understanding the practical implications of their use.

Topics/Contents:

- Intoduction of Scilab with some basic commands.
- Basic operations on matrices.
- Regula-Falsi Method and Newton raphson Method.
- Eigen values & Eigen vectors ,Diagonalization.
- Newton's forward interpolation formula and Newton's backward interpolation formula
- Newton's backward interpolation formula and Newton's divided difference formula.
- Numerical Integration by Trapezoidal Method , Numerical Integration by Simpson's (1/3)rd rule and Numerical Integration by Simpson's (3/8)th rule.
- Euler's Method and Runge-kutta Method.
- Inner Product Spaces.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)						
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3		3			3	3
CO 2	3	3					
CO 3	3						3
CO 4	3	2	3				
CO 5	3						1
CO 6	3					2	
CO 7	3		1			3	

Justification for the mapping

PO1: Computer Knowledge

CO1: Student demonstrating proficiency in using Scilab, including familiarity with the interface, executing basic commands, and navigating the software for numerical computations, enhance their computer knowledge, acquiring essential skills for efficient problem-solving and data analysis in diverse computational applications.

CO2: Student performing basic operations on matrices using Scilab, including addition, multiplication, and inversion, develop a strong foundation for more complex numerical tasks in computer knowledge, equipping them with essential skills for advanced data manipulation and analysis.

CO3: Through practical exercises, students applying the Regula-Falsi and Newton-Raphson methods to find roots of equations gain hands-on experience in solving algebraic and transcendental equations, enhancing their proficiency in numerical methods and problem-solving within the realm of computer knowledge.

CO4: Student compute eigenvalues and eigenvectors using Scilab, demonstrating diagonalization and fostering an understanding of these concepts and their applications in computer knowledge.

CO5: Student apply Newton's forward and backward interpolation formulas, gaining practical skills in interpolating values between data points and approximating unknown values in computer knowledge.

CO6: Student apply Newton’s backward interpolation formula and divided difference formula, understanding their efficiency and limitations in various scenarios, enhancing their computational knowledge and problem-solving skills.
CO7: Student apply numerical methods to real-world problems, developing the ability to choose appropriate methods for specific computational tasks and understanding the practical implications of their use in computer knowledge.

PO2: Design / Development of solution

CO2: Student perform basic matrix operations in Scilab, developing a strong foundation for more complex numerical tasks in the design/development of solutions.

CO4: Student compute eigenvalues and eigenvectors using Scilab, demonstrating diagonalization, fostering an understanding of these concepts, and their applications in the design/development of solutions.

PO3: Modern tool usage
CO1: Student demonstrate Scilab proficiency, including interface familiarity, executing basic commands, and navigating for numerical computations, enhancing modern tool usage skills.
CO4: Student compute eigenvalues and eigenvectors using Scilab, demonstrating diagonalization, fostering understanding, and applying these concepts in modern tool usage.
CO7: Student apply numerical methods to real-world problems, developing the ability to choose appropriate methods and understanding their practical implications in modern tool usage.

PO6: Individual and Team work

CO1: Student proficient in Scilab demonstrate familiarity with the interface, execute basic commands, and navigate for numerical computations, fostering collaborative effectiveness in both individual and team work.
CO6: Students apply Newton’s backward interpolation and divided difference formulas, understanding their efficiency and limitations, enhancing both individual and team work effectiveness.
CO7: Student apply numerical methods to real-world problems, developing the ability to choose appropriate methods and understanding practical implications, fostering effective collaboration in both individual and team work.

PO7: Innovation, employability and Entrepreneurial skills
CO1: Student proficient in Scilab demonstrate familiarity, execute commands, and navigate for numerical computations, enhancing innovation, employability, and entrepreneurial skills.

CO3: Student through practical exercises, apply Regula-Falsi and Newton-Raphson methods to find roots, gaining hands-on experience in solving equations, fostering innovation, employability, and entrepreneurial skills.

CO5: Student using Newton’s forward and backward interpolation, interpolate values, gaining practical skills in approximating unknown values, enhancing innovation, employability, and entrepreneurial skills.

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