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

Autonomous

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

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

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	UCSMT111	Graph Theory	2	36
	UCSMT112	Matrix Algebra	2	36
	UCSMT113	Mathematics Practical based on UCSMT111 & UCSMT112	2	48
II	UCSMT121	Discrete Mathematics	2	36
	UCSMT122	Linear Algebra	2	36
	UCSMT123	Mathematics Practical based on UCSMT121 & UCSMT122	2	48

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

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	UCSMT231	Groups and Coding Theory	2	48
	UCSMT232	Numerical Techniques	2	48
	UCSMT233	Mathematics Practical Python Programming Language I	2	48
II	UCSMT241	Computational Geometry	2	48
	UCSMT242	Operation Research	2	48
	UCSMT243	Mathematics Practical Python Programming Language II	2	48

Equivalence of the Old Syllabus with New Syllabus:

Old Course		New Course	
CSMT1101	Graph Theory	UCSMT111	Graph Theory
CSMT1102	Algebra	UCSMT112	Matrix Algebra
CSMT1103	Mathematics Practical based on CSMT1101 & CSMT1102	UCSMT113	Mathematics Practical based on UCSMT111 & UCSMT112

Choice Based Credit System Syllabus (2022 Pattern)

Class: F.Y.B.Sc.(Computer Science). (Sem I) **Subject:** Mathematics

Course: Graph Theory **Course Code:** UCSMT111

A) Course Objectives:

- To introduce graphs, their types and properties
- To understand applications of graph theory in Computer science
- To build the necessary skill set and analytical abilities for developing computer based solutions using mathematical concepts.
- Identify and analyze special types of graphs.
- Analyze the complement of a graph and identify self-complementary graphs.
- Calculate distance between vertices, eccentricity, center, radius, and diameter of a graph.
- Understand binary trees and tree traversal techniques (preorder, inorder, postorder).

B) Course Outcome:

1. Understanding of algorithms and applications to computer science.
2. Calculate and interpret vertex degrees in different graph structures, showcasing proficiency in graph analysis.
3. Develop a comprehensive understanding of various definitions related to graph theory and apply them to analyze and solve problems.
4. Identify and analyze bridges within a graph, showcasing the ability to recognize critical components in network structures.
5. Apply algorithms to solve the Travelling Salesman Problem, demonstrating proficiency in solving optimization problems in graph theory.
6. Understand and apply concepts of flow and cuts in directed graphs, demonstrating proficiency in analyzing network flows.
7. Comprehend the matrix representation of graphs and utilize it for solving problems related to graph structures.

TOPICS/CONTENTS

Unit 01: Graphs (6 lectures)

1.1 Definition, Elementary terminologies and results, Graph as Models.
1.2 Special types of graphs.
1.3 Isomorphism.
1.4 Adjacency and incidence Matrix of a graph.

Unit 02: Operations on Graphs (4 lectures)

2.1 Subgraphs, induced subgraphs, Vertex deletion Edge deletion .
2.2 Complement of a graph and self - complementary graphs.
2.3 Fusion of vertices.

Unit 03: Connected Graphs (9 lectures)

3.1 Walk, Trail, Path, Cycle: Definitions and elementary properties.
3.2 Connected Graphs: Definition and properties.
3.3 Distance between two vertices, Eccentricity, Centre, Radius and Diameter of a graph.
3.4 Isthmus, Cutvertex : Definition and properties.
3.5 Cutset, Edge-connectivity, Vertex-connectivity.
3.6 Weighted Graph and Dijkstra's Algorithm.

Unit 04: Eulerian and Hamiltonian Graphs (5 lectures)

4.1 Seven Bridge Problem, Eulerian Graph : Definition and Examples, N & S condition.
4.2 Fleury's Algorithm.
4.3 Hamiltonian Graphs : Definition and Examples, Necessary Condition.
4.4 Introduction of Chinese Postman Problem and Travelling Salesman Problem.

Unit 05: Trees (6 lectures)

5.1 Definiton, Properties of trees.
5.2 Centre of a tree.
5.3 Binary Tree : Definiton and Properties.
5.4 Tree Traversal : Ordered rooted Tree, Preorder Traversal, Inorder Traversal and Postorder Traversal, Prefix Notation.
5.5 Spanning Tree : Definiton, Properties, Shortest Spanning Tree, Kruskal's Algorithm.

Unit 06: Directed Graphs (6 lectures)

6.1 Definition, Examples, Elementary Terminologies and Properties.
6.2 Special Types of Digraphs.
6.3 Connectedness of Digraphs.
6.4 Network and Flows : Definition, Examples.

Text Book: John Clark and Derek Holtan, *A First Look at Graph Theory*, Allied Publishers
Unit 1: Sections 1.1to 1.4, 1.7
Unit 2: Sections 1.5, 1.8
Unit 3: Sections 1.6, 2.5, 2.6
Unit 4: Sections 3.1 to 3.4
Unit 5: Sections 2.1 to 2.4
Unit 6 : Sections 7.1, 7.2, 8.1, 8.2

Reference Books:

1. Kenneth Rosen, *Discrete Mathematics and Its Applications*, Tata McGraw Hill.
2. Narsingh Deo, *Graph Theory with Application to Computer Science and Engineering*, Prentice Hall.
3. Douglas B. West, *Introduction to Graph Theory*. Pearson Education, Second Edition.

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	2				1	2
CO 2	3		2				
CO 3	1	3				1	3
CO 4	3		1				1
CO 5		3	2				
CO 6	3		1				3
CO 7	3					3	1

Justification for the mapping

PO1: Computer Knowledge

CO1: Understanding algorithms equips students with problem-solving prowess and strategic thinking, pivotal for unraveling complexities in computer science applications and fostering a profound grasp of the discipline.

CO2: Proficiently calculating and interpreting vertex degrees in diverse graph structures demonstrates students' mastery in graph analysis, a critical skill for solving real-world problems in computer science.

CO3: Developing a comprehensive understanding of graph theory definitions enables students to apply analytical skills for problem-solving in diverse computer science scenarios.

CO4: Proficiently identifying and analyzing bridges within a graph demonstrates students' capacity to discern crucial components in network structures, enhancing their expertise in computer science.

CO6: Mastering the concepts of flow and cuts in directed graphs showcases students' proficiency in analyzing network flows, a critical skill for solving complex problems in computer science.

CO7: Acquiring the ability to comprehend matrix representation of graphs empowers students to effectively utilize this powerful tool for problem-solving in diverse graph structures within the realm of computer science.

PO2: Design / Development of solution

CO1: Understanding algorithms is crucial for students in the design and development of solutions in computer science, enabling efficient problem-solving, optimized coding practices, and the creation of innovative and effective software solutions.

CO3: Developing a comprehensive understanding of graph theory definitions equips students to analyze and solve problems in the design and development of solutions, fostering effective representation and manipulation of complex relationships in various computational scenarios.

CO5: Applying algorithms to solve the Travelling Salesman Problem showcases students' proficiency in addressing optimization challenges within graph theory, a critical skill for designing and developing efficient solutions in various computational contexts.

PO3: Modern tool usage

CO2: Calculating and interpreting vertex degrees in various graph structures demonstrates students' proficiency in graph analysis, a crucial skill in modern tool usage for understanding and manipulating complex networks and relationships.

CO4: Identifying and analysing bridges within a graph demonstrates the student's ability to recognize critical components in network structures, showcasing essential skills for effective analysis and optimization in modern tool usage.

CO5: Applying algorithms to solve the Travelling Salesman Problem showcases the student's proficiency in utilizing modern tools for solving complex optimization problems in graph theory, a valuable skill for algorithmic analysis and practical problem-solving in diverse applications.

CO6: Understanding and applying concepts of flow and cuts in directed graphs demonstrates the student's proficiency in modern tool usage, showcasing their ability to analyze network flows effectively—a critical skill for optimizing transportation, communication, and resource allocation in various applications.

PO6: Individual and Team work

CO1: Understanding algorithms is essential for effective individual and team work in computer science, fostering collaborative problem-solving, streamlined workflows, and innovative solutions.

CO3: Developing a comprehensive understanding of graph theory definitions and their application fosters effective problem analysis and solving, enhancing individual and team capabilities in tackling diverse challenges collaboratively.

CO7: Comprehending matrix representation of graphs and utilizing it for problem-solving enhances individual and team capabilities, enabling collaborative analysis and efficient solutions in diverse graph-related challenges.

PO7: Innovation, employability and Entrepreneurial skills

CO1: Understanding algorithms in computer science fosters innovation, employability, and entrepreneurial skills by equipping individuals with the problem-solving and computational thinking necessary to drive technological advancements and succeed in dynamic, competitive professional landscapes.

CO3: Developing a comprehensive understanding of graph theory definitions and applying them enhances innovation, employability, and entrepreneurial skills, enabling individuals to address complex challenges and create solutions with a strategic and inventive mindset.

CO4: Identifying and analyzing bridges within a graph demonstrates the ability to recognize critical components in network structures, fostering innovation, employability, and entrepreneurial skills through a nuanced understanding of complex relationships and system optimization.

CO6: Identifying and analyzing bridges within a graph showcases the ability to recognize critical components in network structures, enhancing innovation, employability, and entrepreneurial skills by enabling strategic optimization and problem-solving in complex systems.

CO7: Comprehending matrix representation of graphs and utilizing it for problem-solving enhances innovation, employability, and entrepreneurial skills by providing a powerful analytical tool for optimizing solutions and fostering strategic thinking in diverse graph-related challenges.

Choice Based Credit System Syllabus (2022 Pattern)

Class: F.Y.B.Sc.(Computer Science). (Sem I) **Subject:** Mathematics

Course: Matrix Algebra **Course Code:** UCSMT112

A) Course Objectives:

1. To understand properties and operations on System of Linear Equations.
2. To understand basic concepts of Determinants.
3. Understanding of how to translate a linear equation into a matrix.
4. Understand the geometry of linear equations and its practical implications.
5. Demonstrate proficiency in elementary matrices and their applications.
6. Identify and analyze symmetric matrices.
7. Understand the concept of volume in the context of determinants.

B) Course Outcome:

1. Improves problem solving ability and understanding of different algebraic structures in Mathematics.
2. Student are able to define determinants and understand their relation to matrices.
3. Analyze and solve linear equations in the singular case, considering special scenarios and their implications.
4. Apply matrix multiplication to solve problems involving vectors and matrices.
5. Apply matrix multiplication to solve problems involving vectors and matrices.
6. Apply special matrices to real-world problems and recognize their relevance in different applications.
7. Interpret the concept of volume in the context of determinants and understand its practical implications.

TOPICS/CONTENTS

Unit 01: Linear Equations (06 lectures)

1.1 Geometry of Linear Equations
1.2 Column Vectors and Linear Equations
1.3 Singular Case

Unit 02: Matrices (12 lectures)

2.1 Matrix Notation.
2.2 Multiplication of a matrix with a Vector.
2.3 Elementary Matrices.
2.4 Matrix Multiplication.
2.5 Gauss Elimination Method.

Unit 03: Inverses and Transposes (12 lectures)

3.1 Inverse of Matrix by Elementary transformations.
3.2 Gauss Jordan method.
3.3 Transpose of Matrix.
3.4 Symmetric Matrices.
3.5 Special Matrices and Application.

Unit 04: Determinants (6 lectures)

4.1 Introduction to Determinants.
4.2 Properties of Determinants
4.3 Cramer's Rule, Volume.

Text Book : Gilbert Strang, *Linear Algebra and its Applications*, Fourth Edition.

Unit 1: Section 1.1, 1.2
Unit 2: Section 1.3 to 1.5
Unit 3: Section 1.6, 1.7

Text Book : David C. Lay, *Linear Algebra and its Applications*, MacDonald Pearson Publication Fourth Edition. Unit 4: Section 4.1 to 4.3

Reference Books:

1. Howard Anton and others , Elementary Linear Algebra with supplemental Applications , Wiley Student Edition.
2. KantiBhushan Datta , Matrix and Linear Algebra (aided with MATLAB) , Eastern Economic Edition.
3. Franz . F.Hohn , Elementary matrix Algebra Dover Publications , Third Edition.
4. Devi Prasad , Elementary Linear Algebra , Narosa , Third Edition.

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		1				1	2
CO 2			1			2	3
CO 3	3		2				1
CO 4	1						2
CO 5			2			1	
CO 6						2	3
CO 7		1	1			2	1

Justification for the mapping

PO1: Computer Knowledge

CO3: Analyzing and solving linear equations in the singular case is crucial in computer knowledge for addressing unique scenarios, such as degenerate matrices, ensuring robust algorithmic solutions and preventing computational errors in diverse applications like image processing and machine learning.

CO4: Matrix multiplication enables efficient computation of linear transformations, facilitating complex operations on vectors and matrices crucial for various computer applications, such as graphics rendering, neural network calculations, and data manipulation.

PO2: Design / Development of solution

CO1: Enhances cognitive flexibility and analytical skills, fostering a deeper grasp of diverse algebraic structures, thereby bolstering problem-solving proficiency essential for effective solution development in Mathematics.

CO7: Understanding the volume concept in determinants is crucial for solution design, as it provides a geometric insight into the size and orientation of solution spaces, aiding in optimal design and development decisions.

PO3: Modern tool usage

CO2: Understanding determinants is essential for students in modern tool usage as it forms the foundational knowledge necessary to analyze and manipulate matrices, which are fundamental in various fields such as computer science, engineering, and data science.

CO3: Analyzing and solving singular linear equations in modern tool usage enhances problem-solving skills by addressing unique scenarios, promoting critical thinking, and optimizing application of computational tools for real-world implications.

CO5: Matrix multiplication is essential for solving problems involving vectors and matrices in modern tool usage as it enables efficient representation and manipulation of complex linear transformations, facilitating tasks such as computer graphics, machine learning, and data analysis.

CO7: Understanding volume in the context of determinants is crucial for modern tools as it enables efficient manipulation of multidimensional data, facilitating applications in areas such as computer graphics, data analysis, and machine learning.

PO6: Individual and Team work

CO1: Enhances cognitive flexibility and collaborative skills by navigating diverse algebraic challenges, fostering a deeper comprehension of mathematical structures through both individual and team problem-solving experiences.

CO2: Understanding determinants and their relation to matrices enhances students' mathematical proficiency, fostering both individual problem-solving skills and collaborative teamwork in tackling complex linear algebra concepts.

CO5: Matrix multiplication enables efficient and simultaneous computation of complex vector and matrix transformations, enhancing problem-solving capabilities for both individual and team-based tasks.

CO6: Utilizing special matrices in real-world problem-solving enhances analytical efficiency, facilitating precise solutions across diverse applications, showcasing adeptness in both individual and collaborative contexts.

CO7: Understanding the volume concept in determinants is crucial for both individual and team work as it provides a geometric interpretation essential for solving real-world problems involving systems of linear equations and transformations, fostering enhanced analytical and collaborative problem-solving skills.

PO7: Innovation, employability and Entrepreneurial skills

CO1: Enhancing problem-solving skills and grasping diverse algebraic structures cultivates a foundational analytical mind set crucial for innovation, boosts employability by fostering adaptability, and empowers entrepreneurial success through adept problem identification and solution formulation.

CO2: Understanding determinants and their relation to matrices enhances students' problem-solving abilities, fostering innovation, and developing essential employability and entrepreneurial skills through analytical thinking and mathematical foundations.

CO3: Enhancing proficiency in analyzing and solving linear equations in singular cases fosters critical problem-solving skills essential for innovation, employability, and entrepreneurial success by addressing unique scenarios and understanding their consequential impact.

CO4: Matrix multiplication enhances problem-solving in innovation, employability, and entrepreneurial skills by providing a powerful computational framework for optimizing complex operations, data analysis, and strategic decision-making within diverse multidimensional contexts.

CO6: Applying special matrices enhances problem-solving in diverse fields, fostering innovation by leveraging mathematical structures for real-world solutions, thereby cultivating employability and entrepreneurial skills through a versatile understanding of matrix applications.

CO7: Understanding the concept of volume in determinants enhances innovation by fostering spatial reasoning, boosts employability by strengthening analytical skills, and empowers entrepreneurial endeavors by providing a foundation for strategic decision-making in three-dimensional scenarios.

Choice Based Credit System Syllabus (2022 Pattern)

Class: F.Y.B.Sc.(Computer Science). (Sem I) **Subject:** Mathematics

Course: Mathematics Practical based on UCSMT111 & UCSMT112 **Course Code:** UCSMT113

A) Course Objectives:

1. Problem solving ability and understanding applications of Graph Theory.
2. Improve skills to handle abstract algebraic structures such as matrices, determinants.
3. To build the necessary skill set and analytical abilities for developing computer based solutions using mathematical concepts.
4. Solve problems involving the representation of graphs and various graph operations.
5. Apply graph theory concepts to real-world problems.
6. Solve advanced problems involving matrix multiplication, elementary matrices, and Gaussian elimination.
7. Apply algebraic techniques to solve problems from different areas.

B) Course Outcome:

1. Lead students to apply these mathematical concepts in the study of computer science
2. Student are able to solve the System of Linear Equations.
3. Identify and apply concepts related to connected components and graph connectivity.
4. Apply matrix algebra to represent and solve linear systems.
5. Apply algorithms for finding paths and cycles in directed graphs.
6. Compute inverses of matrices using different methods.
7. Apply determinant properties to solve problems.

Title of Experiments:

Graph Theory:

1. Problems on Graphs and Operations on Graphs.
2. Problems on Connected Graphs.
3. Problems on Eulerian and Hamiltonian Graphs.
4. Problems on Trees.
5. Problems on Directed Graphs.
6. Miscellaneous

Algebra:

1. Problems on linear Equations.
2. Problems on Matrices I.
3. Problems on Matrices II.
4. Problems on Inverses and Transposes.
5. Problems on Determinants.
6. Miscellaneous.

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	1	2				3	2
CO 2			2				1
CO 3	1	2					
CO 4		3				1	2
CO 5			2			2	
CO 6		1	2				
CO 7			1			3	2

Justification for the mapping

PO1: Computer Knowledge

CO1: Integration of mathematical concepts in computer science education cultivates analytical thinking and problem-solving skills essential for algorithm design and optimization, enhancing students' proficiency in computational applications.

CO3: Understanding connected components and graph connectivity is crucial in computer knowledge for efficient network analysis, data clustering, and optimization, enabling effective problem-solving in various domains like social networks, transportation systems, and computer networks.

PO2: Design / Development of solution

CO1: Empowering students to apply mathematical concepts enhances their proficiency in the design and development of solutions in computer science, fostering a holistic understanding and practical application of theoretical principles.

CO3: Understanding and applying concepts related to connected components and graph connectivity is crucial for designing and developing solutions that require efficient data organization, network analysis, and component-based relationships, optimizing overall system performance and functionality.

CO4: Utilizing matrix algebra enhances the efficiency and precision of solving linear systems,streamlining the design and development of solutions by providing a powerful mathematical framework for representation and analysis.

CO6: Computing inverses of matrices using various methods enhances the versatility and efficiency of solution design, enabling robust and adaptable solutions in diverse applications such as optimization, control systems, and data analysis.

PO3: Modern tool usage

CO2: Modern tools enable students to efficiently solve systems of linear equations, fostering enhanced computational skills and promoting a deeper understanding of mathematical concepts.

CO5: Efficient path and cycle algorithms in directed graphs enhance navigation and optimization tasks, crucial for modern tool usage in fields such as network routing, logistics, and resource allocation.

CO6: Computing inverses of matrices using various methods in modern tools enhances numerical stability, efficiency, and accuracy in solving linear systems and facilitates robust applications in diverse fields such as machine learning, optimization, and scientific computing.

CO7: Applying determinant properties facilitates efficient problem-solving in modern tools by enabling the analysis of linear transformations, system of equations, and geometric

transformations, crucial for diverse applications such as computer graphics, data science, and optimization algorithms.

PO6: Individual and Team work

CO1: Empowering students to apply mathematical concepts in computer science enhances their analytical and problem-solving skills, fostering both individual proficiency and collaborative effectiveness essential for success in the dynamic field of computer science.

CO4: Utilizing matrix algebra enhances both individual and team capabilities by providing a concise and powerful toolset for representing and solving complex linear systems, fostering efficient problem-solving and collaboration.

CO5: Applying algorithms for finding paths and cycles in directed graphs enhances individual and team problem-solving capabilities, facilitating efficient navigation and analysis of complex relationships within diverse data sets.

CO7: Applying determinant properties enhances problem-solving efficiency in both individual and team work by providing a systematic approach to analyze and manipulate matrices, facilitating better understanding and collaboration in complex tasks.

PO7: Innovation, employability and Entrepreneurial skills

CO1: Empowering students to apply mathematical concepts in computer science fosters innovation, enhances employability, and cultivates entrepreneurial skills by providing a solid foundation for problem-solving and critical thinking in the rapidly evolving technological landscape.

CO2: Proficiency in solving systems of linear equations enhances students' innovation, employability, and entrepreneurial skills by fostering analytical problem-solving, critical thinking, and mathematical modeling abilities essential in diverse professional and entrepreneurial contexts.

CO4: Applying matrix algebra enhances problem-solving efficiency, enabling innovative solutions in diverse fields, fostering employability through advanced analytical skills, and empowering entrepreneurs to optimize resource allocation and decision-making in complex systems.

CO7: Applying determinant properties enhances problem-solving in innovation, employability, and entrepreneurial skills by fostering analytical thinking, strategic decision-making, and adaptability, essential for navigating dynamic and uncertain business landscapes.

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