Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
23BCAA1	DIGITAL LOGIC FUNDAMENTALS	Elective Course 1	3	-	-	-	3	25	75	100

Course Objective	
CO1	To introduce the fundamentals of number systems and Digital logic.
CO2	To understand Boolean algebra, conversions and Binary arithmetic operations.
CO3	To get exposure to combinational logic circuits.
CO4	To understand the concept of sequential logic and flipflops
CO5	To study the design of counters and understand the memory types.

	Contents	No. of Hours
UNIT I	**NUMBER SYSTEMS AND DIGITAL LOGIC** Number Systems and Codes: Number System – Base Conversion – Binary Codes – Code Conversion. Digital Logic: Logic Gates – Truth Tables – Universal Gates.	**15**
UNIT II	**BOOLEAN ALGEBRA** Boolean Algebra: Laws and Theorems – SOP, POS Methods – Simplification of Boolean Functions – Using Theorems, K-Map, Prime – Implicant Method – Binary Arithmetic: Binary Addition – Subtraction – Various Representations of Binary Numbers – Arithmetic Building Blocks – Adder – Subtractor.	**15**
UNIT III	**COMBINATIONAL LOGIC** Combinational Logic: Multiplexers – Demultiplexers – Decoders – Encoders – Code Converters – Parity Generators and Checkers.	**15**
UNIT IV	**SEQUENTIAL LOGIC** Sequential Logic: RS, JK, D, and T Flip-Flops – Master-Slave Flip-Flops. Registers: Shift Registers – Types of Shift Registers.	**15**
UNIT V	**COUNTERS AND MEMORY** Counters: Asynchronous and Synchronous Counters - Ripple, Mod, Up-Down Counters– Ring Counters. Memory: Basic Terms and Ideas –Types of ROMs – Types of RAMs.	**15**
	Total Hours	**75**

	Course Outcome	Programme Outcome
CO	On completion of this course, students will	
1	Identify the logic gates and their functionality.	PO1, PO3,PO5
2	Perform number conversions from one system to another system.	PO2, PO3, PO6, PO7
3	Understand the functions of combinational circuits.	PO3, PO4, PO7
4	Perform number conversions.	PO4, PO5, PO6
5	Perform Counter design and learn its operations.	PO7, PO8

Text Book

1. D.P.Leach and A.P.Malvino, Digital Principles and Applications – TMH – Fifth Edition – 2002.

Reference Books

1. V.Rajaraman and T.Radhakrishnan, Digital Computer Design, Prentice Hall of India, 2001
2. M. Moris Mano, Digital Logic and Computer Design, PHI, 2001.
3. T.C.Bartee, Digital Computer Fundamentals, 6th Edition, Tata McGraw Hill, 1991.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	S	S	M	S	M
CO2	S	S	S	M	S	S	M	S
CO3	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome
S – Strong, M – Medium, L – Low

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
23BCAAP1	Digital Principles & Computer Organization -LAB	Allied Lab	-	-	2	-	2	25	75	100

Course Objectives:

1. To Understand the Digital Electronics Practically
2. To know how to solve gates and other functions.
3. To create Boolean laws.
4. Be able to work with flip-flops.
5. Be able to build multiplexer and de-multiplexer.

LAB EXERCISES	Required Hours
AND ,ORandNOTGateusingTruthTable UniversalityofNAND&NORgates. Verification ofBooleanlawsusingNANDgates(AssociativeCommutative&DistributiveLaws) VerifyDe-Morganstheorem VerificationofBooleanlawsusingNORgates(Associative,Commutative&DistributiveLaws) SumofProductsusingNANDgatesandProductofSums usingNORGates. 4-bitbinaryparalleladderandSubtractorIC7483 CounterusingIC7473 StudyofRS,D,TandJKFlip-FlopswithIC's. StudyofEncoder&Decoder. StudyofMultiplexer&De-Multiplexer. Half and Full AdderusingSimple&NANDGates. HalfandFullSubtractorusingSimple&NANDGates.	**60**

Course Outcomes

On completion of this course, students will

CO1	Demonstrate the understanding of digital electronics
CO2	Identify the problem and solve using gates and other functions.
CO3	Identify suitable programming Boolean laws.
CO4	Learners can be work with flip-flops.
CO5	Develop multiplexer and de-multiplexer.

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**2**	**2**	**2**	**2**	**3**	**2**
CO2	**2**	**1**	**3**	**2**	**-**	**2**
CO3	**3**	**3**	**1**	**1**	**1**	**2**
CO4	**2**	**3**	**3**	**1**	**-**	**1**
CO5	**3**	**2**	**3**	**1**	**1**	**-**
Weightage of course contributed to each PSO	12	11	12	7	5	7

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAA2	**Resource Management Techniques**	**Allied**	3	-	-	-	3	3	25	75	100

Course Objective		
CO 1	Describe the fundamental concepts of operations research and linear programming concepts.	
CO 2	Understand the mathematical formulation and optimality test.	
CO 3	Describe the concept of transhipment problem and assignment problem.	
CO 4	Classify the sequencing problems.	
CO 5	Demonstrate the use of network scheduling by PERT/CPM.	
	Details	**No. of Hours**
UNIT I	**Basics of Operations Research:** Introduction – Scope of Operations Research – Phases of Operations Research -**Linear Programming:** Introduction – Formulation of LP Problems – **Graphical Method:** Procedure for Solving LPP by Graphical Method.	6
UNIT II	**Transportation Problem:** Introduction – Mathematical Formulation – Definitions – Optimal Solution – North-West Corner Rule – Least Cost or Matrix Minima Method – Vogel's Approximation Method – Optimality Test – MODI Method.	6
UNIT III	**Transhipment and Assignment Problems:** Introduction – Transhipment Problem – Assignment Problem – Hungarian Method Procedure – Unbalanced Assignment Problem- Maximization in Assignment Problem.	6
UNIT IV	**Sequencing Problems:** Introduction – Definition – Terminology and Notations – Principal Assumptions – Type I: Problems with n Jobs through Two Machines – Type II: Processing n Jobs through Three Machines A, B, C – Type III: Problems with n Jobs and k Machines – Type IV: Problems with 2 Jobs through k Machines.	6
UNIT V	**Network Scheduling by PERT/CPM:** Introduction - Basic Terms - Common Errors - Rules of Network Construction - Numbering the Events (Fulkerson's Rule) - Time Analysis – Critical Path Method (CPM).	6
	Total	**30**

	Course Outcomes	**Programme Outcome**
CO	Upon completion of the course the students would be Able to:	
CO 1	Remember the fundamental concepts of operations research and linear programming concepts.	PO1, PO6
CO 2	Understand the mathematical formulation and optimality test.	PO2
CO 3	Apply the concept of transhipment problem and assignment problem	PO4, PO7
CO 4	Analyze the sequencing problems.	PO6
CO 5	Understand the use of network scheduling by PERT/CPM.	PO7, PO8

Text Book	
1	S.D. Sharma, Operations Research (Theory, Method & Applications) - Kedar Nath Ram Nath & Co – 1997.
Reference Books	
1.	Hamdy A. Taha, Operations Research- An Introduction, Pearson Education, 10th Edition, 2019.
2	Frederick S. Hillier, Gerald J. Lieberman et al., Introduction to operations Research, 11th Edition, TATA McGraw Hill, 2021
Web Resources	
1.	https://www.mooc-list.com/tags/operations-research

S-Strong-3 M-Medium-2L-Low-1

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**2**	**1**	**-**	**-**	**1**
CO2	**2**	**2**	**2**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**1**	**-**
CO4	**1**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**2**	**1**	**2**	**3**	**2**
Weightage of course contributed to each PSO	12	9	6	5	6	4

Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAAP2	**Resource Management Techniques Lab (Using C/C++/Python)**	**Allied Lab**	-	-	2	-	2	2	25	75	100

Course Objective	
CO1	Describe the linear programming model.
CO2	Understand the basic function of drawing the feasible region.
CO3	Describe the concept of north west corner rule.
CO4	Classify the Vogel's approximation rule and assignment problem.
CO5	Demonstrate the job sequencing problem and network scheduling by PERT/CPM.

S. No	**List of Lab Programs**	**No. of Hours**
1	Write a program to formulate the Linear Programming Model	**30**
2	Write a Program to represent the feasible region graphically	
3	Write a program to Implement the North-West Corner Rule	
4	Write a program to implement the Vogel's Approximation method	
5	Write a program to implement the assignment problem	
6	Write a program to implement the Hungarian Method	
7	Write a program to implement Job sequencing Problem	
8	Write a program to implement the Network Scheduling by PERT/CPM	

Course Outcomes		**Programme Outcome**
CO	Upon completion of the course the students would be able to:	
CO1	Remember the linear programming model.	PO1, PO6
CO 2	Understand the programming basic function of drawing the feasible region	PO2
CO 3	Apply the programming concept of north west corner rule	PO4, PO7
CO 4	Analyze the Vogel's approximation rule and assignment problem.	PO6
CO 5	Know the job sequencing problem and network scheduling by PERT/CPM.	PO7, PO8

Text Book	
1	S.D. Sharma, Operations Research (Theory, Method & Applications) - Kedar Nath Ram Nath & Co – 1997.

Reference Books	
1.	Hamdy A. Taha, Operations Research- An Introduction, Pearson Education, 10th Edition, 2019.
2.	Frederick S. Hillier, Gerald J. Lieberman et al., Introduction to operations Research, 11th Edition, TATA McGraw Hill, 2021

Web Resources	
1.	https://www.mooc-list.com/tags/operations-research

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**2**	**1**	**-**	**-**	**1**
CO2	**2**	**2**	**2**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**1**	**-**
CO4	**1**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**2**	**1**	**2**	**3**	**2**
Weightage of course contributed to each PSO	12	9	6	5	6	4

S-Strong-3 M-Medium-2L-Low-1

Illustration for B.C.A. Allied Paper II Year – Semester – III & IV

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAA3	**Discrete Mathematics**	**Allied**	3	-	-	-	3	3	25	75	100

Course Objective	
CO 1	Describe the fundamental concepts of set theory, functions and relations.
CO 2	Understand the mathematical formulation, Conditional Statements, Atomic and Compound Statements.
CO 3	Describe the concept and Principles of Normal Forms, Theory of Inference.
CO 4	Classify the insights of graph theory.
CO 5	Demonstrate the trees and Boolean algebra.

UNIT	**Details**	**No. of Hours**
UNIT I	**Fundamental Structures:-** Set Theory, Sets, Venn Diagrams, Complements, Cartesian Products, Power Sets, Finite and Infinite Sets. **Functions:-** Surjections, Injections, Inverses, Composition. **Relations:-** Reflexivity, Symmetry, Transitivity, Equivalence Relations.	6
UNIT II	**Logic:-** TF Statements, Connective, Disjunction, Negation, Conditional Statements, Bi Conditional Statements, Atomic and Compound Statements, Well formed Formulae, The Truth Table, Tautology, Tautological Implication Formulae with Distinct Truth Tables.	6
UNIT III	**Normal Forms:-** Principles of Normal Forms, Theory of Inference, Open Statements, Quantifiers, Valid Formulae and Equivalence, Theory of Inference for Predicate Calculus.	6
UNIT IV	**Graph Theory:-** Definition, Degrees, Sub Graph, Isomorphism, Complete Graph, Bipartite Graph – Representation of a Graph – Adjacency Matrix.	6
UNIT V	**Trees:** Spanning Tree – Kruskal's Algorithm, Prim's Algorithm, Dijkstra's Algorithm, **Boolean Algebra:-** Boolean Algebra, Boolean Functions.	6
	Total	**30**

	Course Outcomes	Programme Outcome
CO	Upon completion of the course the students would be Able to:	
CO 1	Remember the fundamental concepts of set theory, functions and relations.	PO1, PO6
CO 2	Understand the mathematical formulation Conditional Statements, Atomic and Compound Statements..	PO2
CO 3	Describe the concept and Principles of Normal Forms, Theory of Inference.	PO4, PO7
CO 4	Analyze and Classify the insights of graph theory.	PO6
CO 5	Understand the use trees and Boolean algebra.	PO7, PO8
Text Book		
1	Jean-Paul Trembly & Manohar, R. (2017). *Discrete Mathematics Structures with Applications to Computer Science.* Tata Mc Graw-Hill.	
Reference Books		
1.	Venkataraman, M.K., Sridharan, N., & Chandrasekaran, N. (2009). *Discrete Mathematics*. National Publishing co.	
Web Resources		
1.	https://mathworld.wolfram.com/DiscreteMathematics.html	

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**2**	**1**	**-**	**-**	**1**
CO2	**2**	**2**	**2**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**1**	**-**
CO4	**1**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**2**	**1**	**2**	**3**	**2**
Weightage of course contributed to each PSO	**12**	**9**	**6**	**5**	**6**	**4**

S-Strong-3 M-Medium-2L-Low-1

Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAAP3	**Excel & C++ Lab for Discrete Mathematics**	**Allied Lab**	-	-	2	-	2	2	25	75	100

Course Objective	
CO1	To impart the knowledge about solving Logical problems
CO2	Understand and create truth table using spreadsheets.
CO3	Understand and create spreadsheets for demorgan's theorem.
CO4	Classify the various set operations.
CO5	Demonstrate and implement prim's algorithms.

S. No	**List of Lab Programs**	**No. of Hours**
1	Create a truth table using spreadsheet for AND, OR and NOT functions.	**30**
2	Create a truth table using spreadsheet for XOR of two variables, using your spreadsheet's AND, OR, and NOT functions to calculate the truth value.	
3	Create a truth table, using your spreadsheet's logical functions, for the expression: **((**P ∧7Q**)** ∨ **(**7P ∧Q).	
4	Create a truth table using your spreadsheet for demorgan's theorem.	
5	Create a truth table using spreadsheet to check whether the given expression is tautology or not (P ∧Q) ∨ **(**7P ∧Q) ∨ **(**P∧7Q) ∨ **(**7P ∧7Q)	
6	Write a C++ Program to implement various set operations (union, intersection, difference, symmetric difference).	
7	Write a C++ Program to find power set of a set with size n.	
8	Write a C++ program to perform following operation: a) is the given relation is reflexive? b) is the given relation is symmetric? c) is the given relation is Transitive?	
9	Write C++ Program to implement Prim's Algorithm.	
10	Write a C++ Program to check whether a given graph is bipartite or not.	

Course Outcomes		**Programme Outcome**
CO	Upon completion of the course the students would be able to:	
CO1	Remember the truth table using spreadsheets.	PO1, PO6
CO 2	Understand the programming basic function and knowledge about solving Logical problems.	PO2
CO 3	Apply the programming concept of spreadsheets for demorgan's theorem.	PO4, PO7
CO 4	Analyze the various set operations and problem.	PO6
CO 5	Know to demonstrate and implement prim's algorithms..	PO7, PO8

Text Book	
1	Jean-Paul Trembly & Manohar, R. (2017). Discrete Mathematics Structures with Applications to Computer Science. Tata Mc Graw-Hill.

Reference Books

1.	Venkataraman, M.K., Sridharan, N., & Chandrasekaran, N. (2009). *Discrete Mathematics*. National Publishing co.
Web Resources	
1.	https://mathworld.wolfram.com/DiscreteMathematics.html

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**2**	**1**	**-**	**-**	**1**
CO2	**2**	**2**	**2**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**1**	**-**
CO4	**1**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**2**	**1**	**2**	**3**	**2**
Weightage of course contributed to each PSO	12	9	6	5	6	4

Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAA4	**STATISTICS METHODS AND ITS APPLICATIONS**	**Allied**	3	-	-	-	3	3	25	75	100

Course Objective	
CO 1	Describe the fundamental concepts of collecting and presenting statistical data.
CO 2	Understand the measures of central tendency and dispersion
CO 3	Describe the concept and Measures of Skewness, Kurtosis and Moments.
CO 4	Classify the insights of correlation and Concurrent deviation method.
CO 5	Demonstrate the regression.

UNIT	**Details**	**No. of Hours**
UNIT I	**Collection and Presentation of Statistical Data**: Nature, Scope and Limitations of Statistics – Data sources – Methods of collection of statistical data – Census – Sample Survey – Measurement of Scales – Nominal, Ordinal, Interval and Ratio scales – Classification and Tabulation – Formation of frequency distribution – Cumulative frequency distribution – Diagrammatic and Graphical representation of Data.	6
UNIT II	**Measures of Central Tendency and Dispersion:** Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean for raw and grouped data – Properties – Quartiles, Deciles and Percentiles – Absolute and relative measures of Dispersion – Range – Quartile deviation – Mean deviation - Standard deviation – Coefficient of Variation – Lorenz Curve.	6
UNIT III	**Measures of Skewness, Kurtosis and Moments**: Definition – Calculation of Karl Pearson's, Bowley's and Kelly's coefficient of Skewness – Moments – Raw and Central Moments – Relation between raw and central moments – Measures of Skewness and Kurtosis 15 based on Moments.	6
UNIT IV	**Correlation:** Definition of Correlation – Types of correlation – Methods of correlation – Scatter diagram – Karl Pearson's correlation coefficient – Spearman's rank correlation coefficient – Properties – Concurrent deviation method – Correlation coefficient for ungrouped and grouped bivariate data.	6
UNIT V	**Regression:** Meaning of Regression – Regression lines – Regression coefficients – Regression coefficients for ungrouped and grouped bivariate data – Properties of regression coefficient – Finding the two regression equations of X on Y and Yon X and estimating the unknown values of X and Y.	6
	Total	**30**

	Course Outcomes	**Programme Outcome**
CO	Upon completion of the course the students would be Able to:	
CO 1	Remember the fundamental concepts of collecting and presenting statistical data.	PO1, PO6
CO 2	Understand the measures of central tendency and dispersion.	PO2
CO 3	Describe the concept and and Measures of Skewness, Kurtosis and Moments.	PO4, PO7
CO 4	Analyze the correlation and Concurrent deviation method.	PO6
CO 5	Understand the use of regression.	PO7, PO8

Text Book	
1	Gupta S. P (2002), Statistical Methods, Sultan Chand and Sons, New Delhi.
2	Gupta S. C and Kapoor V. K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3	Goon A. M, Gupta M. K and Dasgupta B (2008), Fundamentals of Statistics, (Vol. - I), World Press Ltd, Calcutta.
4	Bhat B. R, Srivenkataramana T and Madhava Rao K. S (1996), Statistics a Beginner's Text, (Vol. – I), New Age International Publishers, New Delhi.
Reference Books	
1.	Hogg R. V and Craig A. T (2006), Introduction to Mathematical Statistics, MacMillan, London
2	Saxena H. C, Elementary Statistics, Sultan Chand and Sons, New Delhi.
3	Sancheti D. C and V.K Kapoor, Statistics, Sultan Chand and Sons, New Delhi.
4	Agarwal B. L (1996), Basic Statistics (Third Edition), New Age International Publishers, New Delhi.
Web Resources	
1.	https://www.tutorialspoint.com/statistics/data_collection.htm
2	https://www.surveysystem.com/correlation.htm
3	https://www.investopedia.com/terms/r/regression.asp
4	https://course-notes.org/statistics/sampling_theory

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	-	-	1
CO2	2	2	2	1	-	-
CO3	3	1	1	-	1	-
CO4	1	2	1	2	2	1
CO5	3	2	1	2	3	2
Weightage of course contributed to each PSO	12	9	6	5	6	4

Strong-3 M-Medium-2 L-Low-1

Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAAP4	**Computer-Oriented Statistical Methods Lab**	**Allied Lab**	-	-	2	-	2	2	25	75	100

Course Objective	
CO1	To introduce basic statistical methods for the analysis of significance differences in data using C++ programming Language through Excel.
CO2	To introduce various statistical method such as regression, Skewness, etc.
CO3	Understand and perform correlation coefficient.
CO4	Classify the linear regression.
CO5	Demonstrate and compute multi regression.

S. No	**List of Lab Programs**	**No. of Hours**
1	Write a C++ program to execute the basic commands of an array.	**30**
2	Write a C++ program to Create a Matrix and Perform the operations addition, inverse, transpose, and multiplication operations.	
3	Write a C++ program to Execute the statistical functions: mean, median, mode.	
4	Write a C++ program to Execute the statistical functions: Standard Deviation, variance, and covariance.	
5	Write a C++ program to draw the skewness.	
6	Write a C++ program to obtain the correlation coefficient	
7	Write a C++ program to perform the binomial and normal distribution on the data.	
8	Write a C++ program to Perform the Linear Regression.	
9	Write a C++ program to Compute the Least squares means.	
10	Write a C++ program to Compute the Multi Regression.	

Course Outcomes		**Programme Outcome**
CO	Upon completion of the course the students would be able to:	
CO1	Students will able to understand statistical methods for computer analysis	PO1, PO6
CO 2	Students will able to programming with application of Statistical methods	PO2
CO 3	Apply and perform correlation coefficient.	PO4, PO7
CO 4	Analyze the various linear regression program.	PO6
CO 5	Know to compute multi regression.	PO7, PO8

Text Book

1. Goyal, M. (2008). *Computer-based Numerical & Statistical Techniques*. Laxmi Publications, Ltd.
2. Gupta, S. C., & Kapoor, V. K. (2020). *Fundamentals of Mathematical*. Sultan Chand statistics & Sons.

Reference Books

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (1993). *Probability and Statistics for Engineers and Scientists* (Vol. 5). New York: Mac-millan.

Web Resources

1. https://www.tutorialspoint.com/statistics/data_collection.htm
2. https://www.surveysystem.com/correlation.htm

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAA5	**Graph Theory and its Applications**	EC - 4 Allied	3	-	-	-	3	3	25	75	100

Learning Objectives	
LO1	Definition of Graph, sub graph their representations, degree and algebraic operations.
LO2	Connected graphs, weighted graphs and shortest paths
LO3	Trees: Characterizations, spanning tree, minimum spanning trees
LO4	Eulerian and Hamiltonian graphs: Characterization, Necessary and sufficient conditions
LO5	Special classes of graphs: Bipartite graphs, line graphs, chordal graphs.

UNIT	**Contents**	**No. of Hours**
UNIT I	**INTRODUCTION**: Graph-mathematical definition- Introduction – sub graphs –Walks, paths, Circuits connectedness- Components- Euler Graphs- Hamiltonian paths and circuits-Trees- properties of Trees- Distance and centres in Tree- Rooted and Binary Trees	15
UNIT II	**CONNECTIVITY AND PLANARITY:** Introduction to circuits - cut set- properties of cut set- All cut sets –connectivity and separability – Network Flows - 1-Isomorphism - 2-Isomorphism- Combinatorial and Geometric graphs- Planar Graphs – Different representation of planar graph.	
UNIT III	**COLORING AND DIRECTED GRAPH:** Basics of Colouring &Chromatic number – Chromatic partitioning – Graph Colouring – four colour Problem Chromatic polynomial - Matching – Covering - Directed graphs - Types of Directed Graphs – Diagraphs and binary relations – Directed paths- Euler Graph.	15
UNIT IV	**MATRIX REPRESENTATION IN GRAPH:** Matrix representation of graphs, Sub graphs& Quotient Graphs, Transitive Closure digraph, Euler's Path & Circuit (only definitions and examples), spanning Trees of Connected Relations, Prim's Algorithm to construct Spanning Trees, Weighted Graphs, Minimal, Spanning Trees by Prim's Algorithm & Kruskal's Algorithm.	15
UNIT V	**APPLICATIONS OF GRAPH:** Travelling Sales Person Problem with Directed and Un directed Graph, - Graph with n vertices and k colours- Shortest path from one to many Cities with directed graph- Shortest Paths with Un directed Graphs-Connected Components.	15
	Total	**75**

Course Outcomes		**Programme Outcome**
CO	On completion of this course, students will	
CO1	To Introduce the fundamental concepts in graph theory Graphs, subgraphs, walks, Euler graphs, Hamiltonian Paths Tree Properties, Hamiltonian paths and circuits.	PO1,PO6
CO2	Understanding the concepts of Circuits, Cut set and its Properties, Network Flows, Isomorphism and Combinatorial and Planar Graphs.	PO2
CO3	Applying the concept of Colouring with Chromatic Number, Directed Graphs, Matching, Covering Pattern and Euler Graphs.	PO2,PO4
CO4	Analyzing the Various Concepts of Representation of Graphs, Euler Paths Circuit, Kruskals and Prims Algorithms, Connected Components.	PO4,PO6
CO5	Implementation of an application using All Types of Graphs and evaluate the Applications with travelling sales person Problem, K colour Problem with n vertices in a Graph and Shortest Path finding Problem using Directed and Undirected Graphs.	PO5,PO6

Text Book	
1	Narsingh Deo , " Graph Theory with Application to Engineering and Computer Science" Prentice Hall of India 2010(Reprint)
2	Rosen H "Discrete Mathematics and Its Application " Mc Graw Hill , 2007
Reference Books	
1.	Discrete Maths for Computer Scientists & Mathematicians by Mott, Kandel, Baker
2.	Clark J and Holton DA " First look at Graph Theory" Allied Publishers 1995
Web Resources	
1.	Web resources from NDL Library, E-content from open source libraries
2.	1) https://d3gt.com/ 2) https://www.coursera.org/courses?query=graph%20theory

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	1	3	2	3
CO 3	3	3	3	3	2	3
CO 4	3	3	3	3	2	3
CO 5	3	2	3	3	3	3
Weightage of course contributed to each PSO	15	15	13	15	13	15

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCA AP5	**Graph Theory and its applications Lab**	EC – 5 Allied	-	-	2	-	2	2	25	75	100

Learning Objectives	
LO1	Definition of Graph, sub graph their representations, degree and algebraic operations.
LO2	Connected graphs, weighted graphs and shortest paths
LO3	Special classes of graphs: Bipartite graphs, line graphs, chordal graphs.
LO4	Trees: Characterizations, spanning tree, minimum spanning trees
LO5	Eulerian and Hamiltonian graphs: Characterization, Necessary and sufficient conditions

Sl. No.	**Details**	**No. of Hours**
1	Write a Program to find the number of vertices, even vertices, odd vertices and number of edges in a Graph.	60
2	Write a Program to find connectivity in a graph between two vertices is directed or indirected.	
3	Write a program to find degree of the vertices in a graph.	
4	Write a Program to Find Minimum Spanning tree Using Prim's Algorithm	
5	Write a Program to Find Minimum Spanning tree Using Kruskal's Algorithm	
6	Write a Program to find Shortest Path between 2 Vertices using Dijkstra Algorithm	
7	Write a Program to find Shortest Path between every pair of vertices in a graph using Floyd-Warshall's Algorithm.	
8	Write a Program to implement Graph Colouring.	
	Total	**60**

Course Outcomes		**Programme Outcome**
CO	To Introduce the fundamental concepts in graph theory Graphs, sub graphs, walks, Euler graphs, Hamiltonian Paths Tree Properties, Hamiltonian paths and circuits.	
CO1	Understanding the concepts of Circuits, Cut set and its Properties, Network Flows, Isomorphism and Combinatorial and Planar Graphs.	PO1
CO2	Applying the concept of Colouring with Chromatic Number, Directed Graphs, Matching, Covering Pattern and Euler Graphs.	PO1, PO2
CO3	Analysing the Various Concepts of Representation of Graphs, Euler Paths Circuit, Kruskals and Prims Algorithms, Connected Components.	PO4, PO6
CO4	Implementation of an application using All Types of Graphs and evaluate the Applications with travelling sales person Problem, K colour Problem etc.	PO4, PO5, PO6
CO5	To Introduce the fundamental concepts in graph theory Graphs, subgraphs, walks, Euler graphs, Hamiltonian Paths Tree Properties, Hamiltonian paths and circuits.	PO3, PO5

Text Book	
1	Narsingh Deo , " Graph Theory with Application to Engineering and Computer Science" Prentice Hall of India 2010 (Reprint)
2	Rosen H "Discrete Mathematics and Its Application " Mc Graw Hill , 2007
Reference Books	
1.	Discrete Maths for Computer Scientists & Mathematicians by Mott, Kandel, Baker
2.	Clark J and Holton DA " First look at Graph Theory" Allied Publishers 1995
Web Resources	
1.	Web resources from NDL Library, E-content from open source libraries
2.	1) https://d3gt.com/ 2) https://www.coursera.org/courses?query=graph%20theory

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAA6	Computer Oriented Numerical Methods	EC – 6 Allied	3	-	-	-	3	3	25	75	100

Learning Objectives	
LO1	To introduce the various topics in Numerical methods.
LO2	To make understand the fundamentals of algebraic equations.
LO3	To apply interpolation and approximation on examples.
LO4	To solve problems using numerical differentiation and integration.
LO5	To solve linear systems, numerical solution of ordinary differential equations.

UNIT	Contents	No. of Hours
UNIT I	**FUNDAMENTALS OF ALGEBRAIC EQUATION**: Solution of algebraic and transcendental equations-Bisection method – Fixed point iteration method – Newton Raphson method –linear system of equations – Gauss elimination method – Gauss Jordan method .	15
UNIT II	**ITERATIVE, INTERPOLATION AND APPROXIMATION:** Iterative methods - Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by Power method and Jacobi's method for symmetric matrices. Interpolation with unequal intervals – Lagrange's interpolation – Newton's divided difference interpolation	
UNIT III	**INTERPOLATION WITH EQUAL INTERVAL:** Difference operators and relations. - Interpolation with equal intervals – Newton's forward and backward difference formulae.	15
UNIT IV	**NUMERICAL DIFFERENTIATION AND INTEGRATION:** Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule	15
UNIT V	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS:** Single step methods – Taylor's series method – Euler's method – Modified Euler's method - Runge Kutta method for solving(first, second , Third and 4th) order equations – Multi step methods	15
	Total	**75**

Course Outcomes		Programme Outcome
CO	On completion of this course, students will	
CO1	Know how to solve various problems on numerical methods	PO1, PO6
CO2	Use approximation to solve problems	PO2
CO3	Differentiation and integration concept are applied	PO2, PO4
CO4	Apply , direct methods for solving linear systems	PO4, PO6
CO5	Numerical solution of ordinary differential equations	PO5, PO6

Text Book	
1	Balagurusamy, E., Numerical Methods, Tata McGraw Hill, 1999.
2	Rajaraman V., Computer Oriented Numerical Methods, 3rd Edition, Prentice Hall India, New Delhi, 1998.

Reference Book	
1.	Stoor, Bullrich, Computer Oriented Numerical Methods, Springer-Verlag, 1998.
2.	Krishnamurthy, E.V., Sen, S.K., Computer Based Numerical Algorithms, East West Press, 1998.
3.	Jain, M.K., Iyengar, S.R.K., Jain R.K., Numerical Methods : Problems and Solutions, New Age Int.(P) Ltd., New Delhi, 1997.
4.	Jain, M.K., Iyengar, S.R.K., Jain R.J., Numerical Methods for Scientific and Engineering Competition, New Age Int. (P)Ltd., New Delhi, 1997

Web Resources

1.	https://www.udemy.com/course/computer-oriented-numerical-techniques/

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	1	3	2	3
CO 3	3	3	3	3	2	3
CO 4	3	3	3	3	2	3
CO 5	3	2	3	3	3	3
Weightage of course contributed to each PSO	15	15	13	15	13	15

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23BCAAP6	**Computer Oriented Numerical Methods Lab (using C)**	EC – 7 Allied	-	-	2	-	2	2	25	75	100

Learning Objectives	
LO1	To introduce the various topics in Numerical methods.
LO2	To make understand the fundamentals of algebraic equations.
LO3	To apply interpolation and approximation on examples.
LO4	To solve problems using numerical differentiation and integration.
LO5	To solve linear systems, numerical solution of ordinary differential equations.

	Details	**No. of Hours**
1	Write a C Program to find the roots of non-linear equation using bisection method.	60
2	Write a C Program to find the roots of non-linear equation using newton's method	
3	Write a C Program to solve the system of linear equations using gauss - elimination method.	
4	Write a C Program to integrate numerically using Trapezoidal Rule.	
5	Write a C Program to integrate numerically using Simpson's rule.	
6	Write a C Program for Newtons forward difference.	
7	Write a C Program to implement Lagrange's interpolation method for finding f(x) for a given x	
8	Write a C Program to find the largest eigen value of a matrix by power - method.	
9	Write a C Program to find numerical solution of ordinary differential equations by euler's method.	
10	Write a C Program to find numerical solution of ordinary differential equations by runge- kutta method.	
	Total	**60**

Course Outcomes		**Programme Outcome**
CO	On completion of this course, students will	
CO1	Know how to solve various problems on numerical methods	PO1
CO2	Use approximation to solve problems	PO1, PO2
CO3	Differentiation and integration concept are applied	PO4, PO6
CO4	Apply , direct methods for solving linear systems	PO4, PO5, PO6
CO5	Numerical solution of ordinary differential equations	PO3, PO5

Text Book	
1	Balagurusamy, E., Numerical Methods, Tata McGraw Hill, 1999.
2	Rajaraman V., Computer Oriented Numerical Methods, 3rd Edition, Prentice Hall India, New Delhi, 1998.

Reference Books	
1.	Stoor, Bullrich, Computer Oriented Numerical Methods, Springer-Verlag, 1998.
2.	Krishnamurthy, E.V., Sen, S.K., Computer Based Numerical Algorithms, East West Press, 1998.
3.	Jain, M.K., Iyengar, S.R.K., Jain R.K., Numerical Methods: Problems and Solutions, New Age Int. (P)

	Ltd., New Delhi, 1997.
4.	Jain, M.K., Iyengar, S.R.K., Jain R.J., Numerical Methods for Scientific and Engineering Competition, New Age Int. (P) Ltd., New Delhi, 1997
Web Resources	
1.	https://www.udemy.com/course/computer-oriented-numerical-techniques/

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	1	3	2	3
CO 3	3	3	3	3	2	3
CO 4	3	3	3	3	2	3
CO 5	3	2	3	3	3	3
Weightage of course contributed to each PSO	15	15	13	15	13	15

S-Strong-3 M-Medium-2 L-Low-1