Deccan Education Society's

Fergusson College (Autonomous), Pune

Bachelor's Degree in Applied Mathematics

(Department of Mathematics)

Syllabi for B.Sc. (Applied Mathematics)

Choice Based Credit System (CBCS) Syllabus Under National Education Policy (NEP)

To be implemented from Academic Year 2025-2026

Preamble

The **Bachelor of Science in Applied Mathematics with Computer Science** is an interdisciplinary program that integrates the analytical power of mathematics with computational techniques from computer science. This program equips students with strong problem-solving skills, mathematical modelling abilities, and programming expertise, preparing them for careers in scientific research, data analysis, software development, artificial intelligence, and other technology-driven fields.

Students will gain a solid foundation in mathematical concepts such as calculus, linear algebra, numerical methods, and optimization, while also learning key computer science subjects, including programming, algorithms, data structures, and machine learning. The program emphasizes the practical application of mathematics in computing, engineering, finance, and emerging technologies.

With a focus on both theoretical and applied aspects, graduates will be proficient in designing algorithms, developing software solutions, analysing large datasets, and solving real-world problems using mathematical and computational techniques. This combination of applied mathematics and computer science prepares students for a dynamic and evolving job market, as well as further studies in mathematics, computer science, or related disciplines.

Eligibility

(a) Higher Secondary School Certificate (10+2) Science Stream with Mathematics subject or its equivalent examination

OR

(b) Three Years Diploma Course after S.S.C. (10th standard) of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

Programme Outcomes:

PO	Outcomes
PO1	**Disciplinary Knowledge:** Demonstrate a comprehensive understanding of core concepts in Applied Mathematics, including advanced mathematical theories, computational techniques, and statistical methods, with a strong theoretical and practical foundation relevant to professional and academic pursuits.
PO2	**Critical Thinking and Problem Solving:** Exhibit analytical and logical reasoning skills to critically evaluate mathematical problems, interpret data, and design innovative solutions using appropriate mathematical methodologies.
PO3	**Social Competence:** Develop effective communication skills to articulate mathematical ideas clearly in both oral and written forms, collaborate efficiently in teams, and adapt socially in diverse professional and academic environments.
PO4	**Research-Related Skills and Scientific Temper:** Demonstrate proficiency in using mathematical tools, software, and laboratory techniques for conducting research. Design and perform experiments, formulate hypotheses, analyze data, and cultivate an inquisitive approach towards research and development.
PO5	**Trans-Disciplinary Knowledge:** Integrate mathematical knowledge with other disciplines such as computer science, physics, economics, and engineering to address complex real-world problems through a multi-disciplinary approach.
PO6	**Personal and Professional Competence:** Work effectively both independently and collaboratively in multidisciplinary teams, demonstrating leadership, adaptability, and self-motivation while adhering to ethical and professional standards.
PO7	**Effective Citizenship and Ethics:** Promote equity and contribute to community development with an ethical mindset, exhibiting awareness of social responsibilities, and practicing professional integrity in all endeavors.
PO8	**Environment and Sustainability:** Recognize the impact of mathematical solutions in societal and environmental contexts, promoting practices that contribute to sustainable development and ecological balance.
PO9	**Self-Directed and Life-Long Learning:** Cultivate the ability to pursue continuous self-improvement and lifelong learning, adapting to evolving technological and societal changes through independent exploration and knowledge acquisition.

Program Specific Objectives:

PSO	Outcomes
PSO1	**Academic Competence** **(i)** Understand and apply various concepts of Pure and Applied Mathematics, Statistics, and Computational Methods relevant to the discipline. (ii) Utilize mathematical theories and methodologies to model, analyze, and solve real-world problems in diverse domains.
PSO2	**Personal and Professional Competence** (i) Apply fundamental mathematical knowledge in professional settings and develop the ability to acquire new skills independently. (ii) Develop strong analytical, problem-solving, and decision-making abilities, applying mathematical and statistical techniques to design solutions for specific requirements.
PSO3	**Research Competence** (i) Employ mathematical tools, computational techniques, and programming languages to conduct research and develop innovative solutions for interdisciplinary problems. (ii) Integrate mathematical, statistical, and computational knowledge to explore data and contribute to experimental and research-based projects.
PSO4	**Entrepreneurial and Social Competence** (i) Apply mathematical and analytical skills in career paths such as data analysis, quantitative modeling, research, education, and entrepreneurship in emerging fields like data science, financial mathematics, and operations research. (ii) Develop mathematical solutions for industrial and research challenges while fostering skills needed for effective social interaction and collaboration.

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 /60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

Evaluation Methods:

1) Open book test
2) Research paper presentation
3) Test
4) Viva
5) Presentation
6) Subjective Test
7) Flip Classroom etc.

First Year- SEMESTER I										
Course Type	**Theory/ Practical**		**Course Name**	**Credits**		**Teaching Scheme Hrs. /Week**		**Examination Scheme and Marks**		
				TH	**PR**	**TH**	**PR**	**CE**	**EE**	**Total**
Major	Theory	MAM1001	Calculus - 1	2	-	2	-	20	30	50
	Practical	MAM1011	Foundations of Mathematics	-	2	-	4	20	30	50
OE-1	Theory	MAM1021	Linux Commands and Shell Scripting	2	-	2	-	20	30	50
AEC	AEC-1001	AEC	AEC	2	-	2	-	20	30	50
VEC	VEC-1001	VEC	VEC	2	-	2	-	20	30	50
Minor1	Theory	MAM1031	Introduction to Computer Architecture	2	-	2	-	20	30	50
Minor1	Practical	MAM1041	Programming Language- I	-	2		4	20	30	50
Minor2	Theory	MAM1051	Fundamentals of Statistics	2	-	2	-	20	30	50
Minor2	Practical	MAM1061	Statistical Computing using R	-	2	-	4	20	30	50
		Total		**8**	**6**	**8**	**12**			

First Year- SEMESTER II										
Course Type	**Theory/ Practical**	**Code**	**Course Name**	**Credits**		**Teaching Scheme Hrs. /Week**		**Examination Scheme and Marks**		
				TH	**PR**	**TH**	**PR**	**CE**	**EE**	**Total**
Major	Theory	MAM1002	Calculus—2	2	-	2	-	20	30	50
	Practical	MAM1012	Discrete Mathematical Structures	-	2	-	2	20	30	50
OE-2	Theory	MAM1022	Recent Tech Developments	2	-	2	-	20	30	50
SEC	Theory/ Practical	MAM1072	Exploratory Data Analysis (EDA) using MS Excel	-	2	2	-	20	30	50
Minor1	Theory	MAM1032	Probability Distributions	2	-	2	-	20	30	50
Minor1	Practical	MAM1042	Programming Language - 2	-	2	-	4	20	30	50
Minor2	Theory	MAM1052	Data and Databases	2	-	2	-	20	30	50
Minor2	Practical	MAM1062	Practical Based on Data and Databases	-	2	-	4	20	30	50
		Total		**8**	**8**	**10**	**12**			

F. Y. B. Sc. SEM I		
	MAM1001-Calculus -1 **Major-Theory**	
	Number of Credits: 2 **No. of. Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Remember the definitions and statements	**1**
CO2	Understand the theorem and write the proof	**2**
CO3	Apply the statements to solve the problems	**3**
CO4	Analyze the statements to define the necessary and sufficient conditions	**4**
CO5	Solve the problems of limit, evaluate the extreme value	**5**
CO6	Generate the new statements from the given data	**6**

MAM1001-Calculus -1
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of Hours
I	**Preliminaries:** Real numbers and real line, Functions and their graphs, identifying functions, Mathematical models, shifting and scaling graphs, Trigonometric functions, and graphing with computer programming. (Scilab/or any programming language.)	**10**
II	**Limits and Continuity:** Rates of change and Limits, Definitions and examples, One-sided Limits and Limits at infinite Limits and vertical asymptotes, Continuity, Tangents and Derivatives, and Practice problem sets.	**10**
III	**Differentiation:** The derivative as a function, Differentiation rules, Derivative as rate of change, Chain rule and parametric equations, implicit differentiation, and Applications of Derivatives.	**10**

Learning Resources:

Sr. No.	References
1	Thomas' Calculus (14th edition), Pearson Education.
2	Pfaff, T. J. (2023). *Applied Calculus with R*. Springer.
3	Bartle, R. G., & Sherbert, D. R. (2000). *Introduction to real analysis* (Vol. 2). New York: Wiley.

	MAM1011- Foundations of Mathematics -1 **Major-Practical**	
	Number of Credits: 2 **No. of. Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	State basic concepts in Counting and solve examples	**1**
CO2	Discuss the concepts of Counting and advanced counting techniques	**2**
CO3	Apply the concepts of Recurrence relations to model problems in Computer Science	**3**
CO4	Analyze the concept of Inclusion Exclusion to count favorable union of events	**4**
CO5	Determine the Pigeons and Holes to apply the pigeon hole principle	**5**
CO6	Create a set of Boolean identities to model applications in Computer Science	**6**

MAM1011- Foundations of Mathematics -1
Major-Practical

Unit No.	Title of Unit and Contents	No. of Hours
I	**Sets, operations on sets and the integers** Sets, Operations on Sets, Power Set, Cartesian product of Sets, Graphical representation of sets Graphical representation of sets, Relations, types of Relations, Equivalence relations, Partition of a set and equivalence classes. Algorithms, growth of functions, The integers and division, primes and greatest common divisor, integers and algorithms.	**10**
II	**Counting and advanced counting techniques:** The basics of counting, the pigeonhole principle, Permutation and Combination, Binomial coefficients, Recurrence relation, solving linear recurrence relation, inclusion- Exclusion principle and its applications.	**10**
III	**Matrices** Systems of linear equations, Row reduction and echelon forms, operations on matrices, Determinants, the rank of a matrix, the inverse of a matrix, Eigen values and eigenvectors.	**10**

Learning Resources:

Sr. No.	References
1	Edition, S., & Rosen, K. H. Discrete Mathematics and Its Applications.
2	Tucker, A. (2012). Applied combinatorics. Wiley Global Education

	MAM1021- Linux commands and shell scripting **OE-Theory**	
	Number of Credits: 2 **No. of. Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify and describe basic Linux commands, file management techniques, and system monitoring tools.	**1**
CO2	Explain the functionality of file permissions, process management, and the importance of shell scripting in automating tasks.	**2**
CO3	Execute fundamental Linux commands for file management, process control, and system monitoring using the command line.	**3**
CO4	Demonstrate the use of conditional statements, loops, and functions in shell scripting to solve practical problems	**4**
CO5	Assess and debug shell scripts to ensure they execute correctly and efficiently, using techniques such as set -x and set +x.	**5**
CO6	Develop and implement shell scripts for automating tasks such as file backup, system monitoring, and creating custom utility tools	**6**

MAM1021- Linux commands and shell scripting
(OE-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Introduction to Linux and Command Line** Overview of Linux Operating System Accessing the Linux Command Line (Terminal, SSH, Console) Basic Commands: pwd, ls, cd, clear, man, help File and Directory Management: cp, mv, rm, mkdir, rmdir, touch	**4**
II	**File Management and Text Processing** File Permissions and Ownership: chmod, chown, chgrp Viewing and Editing Files: cat, more, less, head, tail, nano, vi Searching and Filtering Text: grep, find, locate Text Processing Tools: cut, sort, uniq, tr, sed, awk	**4**
III	**Process Management and System Monitoring** Managing Processes: ps, top, htop, kill, pkill, jobs, bg, fg Scheduling Tasks: cron, crontab, at System Monitoring: df, du, free, uptime, dmesg Network Commands: ping, ifconfig, netstat, ss	**4**
IV	**Introduction to Shell Scripting** What is Shell Scripting?	**6**

	Writing and Executing Shell Scripts (.sh files) Basic Script Structure: #!/bin/bash, Comments (#) Variables and Data Types ($, env, set, unset) Taking Input and Displaying Output (echo, read)	
V	**Conditional Statements and Loops** Conditional Statements: if, if-else, elif, case Comparison Operators: Numeric (-eq, -ne, -gt, -lt), String (=, !=) Looping Constructs: for, while, until loops Controlling Loops: break, continue	**6**
VI	**Functions, Debugging, and Advanced Scripting** Creating and Using Functions Passing Arguments to Scripts ($1, $2, $@, $*) Script Debugging Techniques (set -x, set +x) Introduction to Advanced Scripting: Arrays, Regular Expressions, Redirection (>, <, |, >>)	**4**
V	**Practical Session and Mini Projects** Writing Scripts for File Backup and Restoration Automating System Monitoring and Reporting Creating Simple Utility Scripts (e.g., Disk Usage Checker) Hands-on Practice and Project Presentation	**2**

Learning Resources:

Sr. No.	References
1	"The Linux Command Line: A Complete Introduction" by William E. Shotts
2	"Linux Pocket Guide" by Daniel J. Barrett
3	"Linux for Beginners" by Jason Cannon
4	"Bash Guide for Beginners" by Machtelt Garrels
5	"Advanced Bash-Scripting Guide" by Mendel Cooper
6	"Linux Shell Scripting Cookbook" by Shantanu Tushar and Sarath Lakshman

	MAM1031- Introduction to Computer Architecture **Minor-Theory**	
	Number of Credits: 2 **No. of. Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the basic concepts of Computer Architecture	**1**
CO2	Discuss different types of number systems and conversions	**2**
CO3	Demonstrate Microoperations and Register Transfer	**3**
CO4	Apply fundamental concepts of functions logic gates	**4**
CO5	Determine the solutions for number system conversions	**5**
CO6	Integrating all the python features to solve the case studies.	**6**

MAM1031- Introduction to Computer Architecture
(Minor-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Understanding the computer:** Introduction, Evolution and Classification of Computers, Computing Concepts, The Computer System	**1**
II	**Computer Organization and Architecture:** Concept of CENTRAL PROCESSING UNIT with bloc diagram of various units such as Arithmetic, Logic, Input, Output unit etc., Internal communications -Processor to memory communication, Processor to I/O devices communication, Bus: Types of Buses Data, Address	**3**
III	**Memory and Storage Systems:** INTRODUCTION Memory Representation -Bit, Byte, Unit of Bytes -KB, MB, GB, TB etc. Memory Types - RAM, ROM, Storage Systems	**2**
IV	**Computer Codes:** Introduction Number Systems – Decimal Systems, Binary Systems, Hexadecimal system, Octal system, 8-bit BCD Systems: ASCII Code, 16-bit Unicode, Conversion of Numbers: Non-decimal to Decimal, Decimal to Non-decimal, 3 Octal to Hexadecimal	**6**
V	**Computer arithmetic:** Introduction, Binary arithmetic operations -addition, multiplication, subtraction, division Signed/Unsigned Numbers, Complements of Binary Numbers -One's Complement, Two's Complement, Error Arithmetic	**6**
VI	**Computer Software:** Types of Computer Software, System Management Programs	**6**

	System Development Programs Standard Application Programs PROBLEM SOLVING -Preparing hierarchy chart, developing algorithm, drawing flowchart, Writing Pseudocode Introduction to Algorithm	
VII	**Operating systems:** Functions of operating systems, Components of operating systems - process management, memory management, file management, device management, security management Types of operating systems-batch processing, multi-user, multitasking, real-time, multiprocessor operating systems Popular operating systems -ms-dos, windows, unix, linux(various flavors),android, iOS etc.	**6**

Learning Resources:

Sr. No.	References
1	E balagurusamy, fundamentals of computers, tata mcgraw hill education private limited
2	V. Rajaraman, fundamentals of computers, b.p.b. publications
3	Pradeep k.sinha,pradeep k.sinha,priti sinha , computer fundamentals, b.p.b. publications

	MAM-1041-Programming language- I **Minor-Practical**	
	Number of Credits: 2 **No. of. Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the basic concepts of programming languages	**1**
CO2	Discuss different features of Python	**2**
CO3	Demonstrate python in built functions and data structures	**3**
CO4	Apply fundamental concepts of functions using Python	**4**
CO5	Determine the solution for a given problem by implanting various libraries	**5**
CO6	Integrating all the python features to solve the case studies.	**6**

MAM-1041-Programming language- I
Minor-Practical

Unit No.	Title of Unit and Contents	No. of hours
I	**Introduction to Programming Language:** Program and Programming Languages, Types of Software, Compiler, Interpreter, Loader, Linker, Introduction to algorithms, Types of Programming Languages, Overview of Python Programming, History, Importance of Python programming Language, Python as interpreter, First Program in Python – use of print () function.	**5**
II	**Basics of Python:** Variables, Primitive Data Types, Keywords, Identifiers, Literals, Operators- Arithmetic, Comparison, Logical, Assignment, Type Conversion and Casting, Comments, Accepting user input (use of input ())	**4**
III	**Control Structures:** Conditional Statements: if, elif, else, Looping Structure: for Loop, while Loop, Nested Loops, Loop Control Statements – break, continue, pass	**6**
IV	**Functions:** What is the function? Definition of a function, calling functions, prototype of a function, Types of function arguments – Positional Argument (Required Argument), Default Argument, Keyword Argument, Anonymous functions, Normal functional Vs Anonymous function, Scope of variables	**6**
V	**Strings and Dats Structures:** Accessing Strings, Basic Operators, Membership Operators, Relational Operators, Slice Notation, String functions and Methods, Formatting Strings (f-strings, str.format())	**4**

VI	**Data Structures: List** - Accessing Lists, List Operations, Functions and Methods of Lists, Tuple - Accessing Tuple, Tuple Operations, Functions and methods of Tuples, why use Tuple? Python Dictionary- Accessing Values, Functions & Methods	**5**

Learning Resources:

Sr. No.	References
1	Beginning-Python, Second Edition by Magnus LieHetland
2	The Complete Reference Python by Martin C.Brown
3	Headfirst Python by PatrickBarry
4	Learning Python, O'Reilly by MarkLutz
5	Python in a Nutshell, O'Reilly by AlexMartelli

	MAM 1051- Fundamentals of Statistics Minor-Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the basic concepts of statistics	**1**
CO2	Discuss types of distributions	**2**
CO3	Demonstrate Measures of Central Tendency	**3**
CO4	Apply fundamental concepts of Conditional probability	**4**
CO5	Determine the solution for real-life problems using various statistical techniques such as distributions, probability etc.	**5**
CO6	Integrating all the fundamental concepts to solve the case studies	**6**

MAM 1051- Fundamentals of Statistics
(Minor-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Introduction to Statistics**: Meaning of Statistics as a Science. Importance of Statistics. Scope of Statistics: In the field of Industry, , Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology Biological sciences, Medical sciences. Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and Statistics	**2**
II	**Population and Sample:** Types of characteristics: Attributes: Nominal scale, ordinal scale, Likert scale, Variables: Interval scale, ratio scale discrete and continuous variables. Types of data: Primary data, Secondary data, Cross-sectional data, Time series data, Directional data. Notion of a statistical population and sample: Finite population, infinite population, homogeneous population and heterogeneous population. Sample and a random sample. Methods of sampling (description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), Stratified Random Sampling, Systematic Sampling, Cluster sampling and Two stage sampling. Inclusion probabilities	**4**
III	**Data classification and representation:** Raw data and its classification, ungrouped frequency distribution, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, open end classes, relative frequency distribution. Histogram, Ogive, bar diagram, subdivided bar diagram, multiple bar diagram, pie chart	**5**

IV	**Measures of Central Tendency:** Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean, mode and median: Definition, formulae, merits and demerits. Empirical relation between mean, median and mode. Partition Values: Quartiles, Deciles and Percentiles, Box Plot. Geometric Mean (G.M.): Definition, formula, merits and demerits. Harmonic Mean (H.M.): Definition. Formula, merits and demerits	**6**
V	**Measures of Dispersion:** Concept of dispersion, Range, Semi-interquartile range (Quartile deviation): Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups). Mean squared deviation: Definition, minimality property of mean squared deviation (without proof), Measures of dispersion for comparison: coefficient of \ range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)	**4**
VI	**Moments Measures of skewness and kurtosis:** Raw moments for ungrouped and grouped data. Central moments for ungrouped and grouped data, Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution. Karl Pearson's coefficient of skewness. Measures of skewness based on moments (β_1,γ_1). Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions. Measures of kurtosis based on moments (β_2,γ_2).	**4**
VI	**Probability, conditional probability, independence:** Experiments / Models, deterministic and non- deterministic models. random experiment, concept of statistical regularity. Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite, (iii) Continuous sample space, Classical definition of probability and its limitations. Probability model, equiprobable and non-equiprobable sample space. Axiomatic definition of probability, theorems of probability, computation of probability of an event conditional probability of an event. 1.5 Independence of two events. Multiplication theorem $P(A \cap B) = P(A) \cdot P(B\|A)$ and its generalization. 1.6 Bayes' Theorem Partition of the sample space. Bayes' theorem (without proof), Applications of Bayes' theorem in real life	**5**

Learning Resources:

Sr. No.	References
1	Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
2	Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
3	Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
4	Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
5	Medhi, J., Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002. 7. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

	MAM1061- Statistical Computing using R **Minor-Practical**	
	Number of Credits: 02/04 **No. of Hours:30/60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall fundamental concepts of R programming, including data structures like vectors and data frames.	1
CO2	Explain the graphical representation techniques in R, such as histograms, pie diagrams, bar diagrams (simple, multiple, and subdivided).	2
CO3	Utilize R programming to implement sampling techniques like Simple Random Sampling with Replacement (SRSWR) and Without Replacement (SRSWOR).	3
CO4	Examine and compare measures of central tendency and measures of dispersion using R.	4
CO5	Assess the use of moments, skewness, and kurtosis in statistical analysis using R, and interpret the results in practical scenarios.	5
CO6	Develop case studies using R to demonstrate the application of istribution theory and analyze central tendency and measures of ispersion effectively.	6

MAM1061- Statistical Computing using R
(Minor-Practical)

Sr. No	Title of Experiment/ Practical
1	Introduction to R, algebraic calculations using R, vectors data frames
2	Graphical representation using R Histogram, pie diagram, bar diagram, multiple bar diagram, subdivided bar diagram
3	Drawing sample using SRSWR, SRSWOR technique.
4	Measures of central tendency Mean, Mode, Median, H.M., G.M
5	Measures of dispersion using R
6	Moments using R, Measures of skewness and kurtosis using R
7	Case Study Based on Distribution Theory
8	Case Study based on Central Tendency and Measure for Dispersion

First Year- SEM II		
	MAM1002- Calculus-2 **Major-Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Understand and learn monotonic functions and their properties.	1
CO2	Familiarize and learn to evaluate limit of function and study continuity	2
CO3	Employ the rules of derivatives	3
CO4	Recognize basic applications of derivatives.	4
CO5	Evaluating differential equations.	5
CO6	Integrating all the fundamental concepts to solve the case studies.	6

MAM1002- Calculus-2
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Applications of Derivatives** Extreme Values of Functions, The Mean Value Theorem, Monotonic Functions and the First Derivative Test, Concavity and Curve Sketching.	**10**
II	**Integrals** Area and Estimating with Finite Sums, Sigma Notation and Limits of Finite Sums, The Definite Integral, The Fundamental Theorem of Calculus, Indefinite Integrals and the Substitution Method, Definite Integral Substitutions and the Area Between Curves.	**10**
III	**Applications of Definite Integrals** Volumes Using Cross-Sections, Volumes Using Cylindrical Shells, Arc Length, Areas of Surfaces of Revolution.	**10**

Learning Resources:

Sr. No.	References:
1	Thomas' Calculus (14th edition), Pearson Education.
2	Pfaff, T. J. (2023). Applied Calculus with R. Springer.
3	Bartle, R. G., & Sherbert, D. R. (2000). Introduction to real analysis (Vol. 2). New York: Wiley

	MAM1012- Discrete Mathematical Structures Major-Practical	
	Number of Credits: 02 No. of Hours:60	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Understand the basic concepts of graph theory, including graphs, vertices, edges, and degrees	1
CO2	Demonstrate problem-solving skills by using graph theory to solve practical problems.	2
CO3	Discuss and apply graph isomorphism and subgraph concepts.	3
CO4	Analyze and apply graph representations, including adjacency matrices and edge incidence matrices	4
CO5	Evaluate properties of graphs, including Eulerian and Hamiltonian paths/cycles, using different algorithms.	5
CO6	Apply various shortest path algorithms.	6

MAM1012- Discrete Mathematical Structures
(Major-Practical)

Unit No.	Title of Unit and Contents	No. of hours
I	**Integers** The integers and division, Primes and Greatest common divisor, Integers and algorithms, applications of number theory, Mathematical Induction.	**7**
II	**Graphs** Graphs, graph models, special types of graphs, representing, paths and cycles, matrix representation of graphs, subgraphs, operations on graphs, introduction to trees, spanning trees, minimal spanning trees, connectivity and trees, applications of trees.	**13**
III	**Applications of Graphs** Euler and Hamiltonian paths, shortest path problem and corresponding algorithms, The Travelling salesman problem, Chinese postman problem and examples, introduction to directed graphs, indegree-outdegree and corresponding examples.	**10**

Learning Resources:

Sr. No.	References
1	Keneth H. Rosen. Discrete Mathematics and Its Applications.
2	Tucker, A. (2012). Applied combinatorics. Wiley Global Education.
3	3John Clark and Derek Allen Holten, Graph Theory

	MAM1022- Recent Tech Developments OE-Theory	
	Number of Credits: 02/04 **No. of Hours:30/60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Understand the basic concepts behind recent trends	**1**
CO2	Familiarize the recent technologies such as – Artificial Intelligence and Machine Learning.	**2**
CO3	Discuss variation applications of Block Chain technologies.	**3**
CO4	Analyze the various opportunities and challenges in future in reference with Extended Reality (XR) Innovations	**4**
CO5	Evaluate recent Industry-Specific Disruptive Innovations	**5**
CO6	Apply various shortest path algorithms.	**6**

MAM1022- Recent Tech Developments
(OE-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Introduction to Recent Tech Trends (3 Hours)** **Overview of Emerging Technologies** Definition and scope of emerging technologies Importance of staying updated with technological advancements Impact on businesses, society, and everyday life **Global Tech Landscape** Key tech hubs (e.g., Silicon Valley, Bengaluru, Shenzhen) Leading tech companies (e.g., Google, Microsoft, Tesla) Role of startups and innovation ecosystems **Innovation Drivers** Role of research and development (R&D) Contributions of academia, industry, and government Technology adoption life cycle and diffusion of innovations	**3**
II	**Artificial Intelligence & Machine Learning (5 Hours)** **Recent Advancements in AI/ML** Generative AI: ChatGPT, DALL·E, Midjourney Natural Language Processing (NLP): Chatbots, sentiment analysis Computer Vision: Image recognition, autonomous vehicles Deep Learning: Neural networks, transformer models **Applications of AI/ML** Healthcare: Diagnostics, predictive analytics, personalized medicine Finance: Fraud detection, trading algorithms, robo-advisors Education: Adaptive learning platforms, grading automation Autonomous Systems: Self-driving cars, robotics in manufacturing **Ethical Considerations and Challenges**	**5**

	Bias in AI models Data privacy concerns Regulatory frameworks and compliance (e.g., GDPR, AI Act)	
III	**Web3, Blockchain, and Decentralized Technologies (4 Hours)** **Blockchain Beyond Cryptocurrency** Decentralized Finance (DeFi): Smart contracts, liquidity pools Supply Chain Management: Transparency and traceability Real-world examples: IBM Food Trust, VeChain **Web3 and Decentralization** Decentralized Apps (dApps): Development frameworks and platforms Non-Fungible Tokens (NFTs): Digital ownership, marketplaces Future of the internet: Peer-to-peer networks, data ownership **Regulatory and Market Trends** Legal challenges and considerations Adoption barriers: Scalability, user experience Market trends: Investment flows, market leaders	**4**
IV	**Extended Reality (XR) Innovations (5 Hours)** Virtual Reality (VR) and Augmented Reality (AR) : Hardware advancements: VR headsets (Meta Quest, PS VR) Software platforms: Unity, Unreal Engine Key use cases: Training simulations, immersive learning, retail experiences Mixed Reality (MR) and The Metaverse: Definition of the Metaverse: Persistent, shared digital spaces Key players: Meta, Microsoft, Roblox, Decentraland Applications: Virtual workplaces, social interactions, digital economies Future Opportunities and Challenges: Scalability and infrastructure needs Accessibility and digital divide issues Ethical implications: Digital identity, content moderation	**5**
V	**Advances in Hardware and Computing (5 Hours)** **Quantum Computing** Principles of quantum mechanics: Qubits, superposition, entanglement Recent breakthroughs: Quantum supremacy, research milestones Potential applications: Cryptography, drug discovery, complex simulations Leading institutions: Google Quantum AI, IBM Q, D-Wave **Edge Computing and Internet of Things (IoT)** Concepts of edge computing: Data processing at the source IoT advancements: Smart devices, sensors, and data analytics Industry use cases: Manufacturing, smart cities, healthcare **Semiconductors and Chip Technology:** Moore's Law and its evolution Advancements in chip design: M1/M2 chips, NVIDIA GPUs Trends: Reduced power consumption, increased processing power	**5**
VI	**Industry-Specific Disruptive Innovations (6 Hours)** **Healthcare and Biotech Innovations** Telemedicine and digital health	**6**

	Wearable technology: Health monitoring, fitness tracking Genomics and personalized medicine: CRISPR, gene editing **Sustainable Technologies** Green energy solutions: Solar, wind, battery technologies Smart city technologies: Energy efficiency, waste management Environmental tech: Carbon capture, pollution control **Fintech and Digital Transformation** Digital payment systems: eWallets, cryptocurrency adoption Insurtech and Regtech: Automation in insurance and compliance Business transformations: Cloud computing, digital operations **Entertainment and Media Innovations** Streaming technologies and platforms Immersive experiences: 360° video, AR-enhanced content Content creation tools: AI-generated media, virtual influencers	
VII	**Case Studies on Successful Tech Innovations (2 Hours)** Google DeepMind: AlphaFold's impact on protein folding Tesla: Advancements in electric vehicles and autonomous driving SpaceX: Innovations in aerospace technology	**2**

Learning Resource:

Sr. No.	References
1	"The Fourth Industrial Revolution" by Klaus Schwab
2	"Technology and Innovation for Sustainable Development" (UNESCO Reports)
3	"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
4	"Neural Networks and Deep Learning" by Michael Nielsen
5	Machine Learning Yearning" by Andrew Ng *(Draft PDF available)*
6	"Mastering Bitcoin" by Andreas M. Antonopoulos *(First edition is free)*
7	"Blockchain for Dummies" (IBM Limited Edition)
8	"Ethereum and Solidity: The Complete Developer's Guide" (Free articles & tutorials)
9	"Augmented Reality for Developers" by Jonathan Linowes and Krystian Babilinski
10	The VR Book: Human-Centered Design for Virtual Reality" by Jason Jerald
11	"Quantum Computing for Computer Scientists" by Noson S. Yanofsky and Mirco A. Mannucci
	Open Education Resources (OERs)
	• **MIT Open Course Ware (Free courses on AI, Blockchain, Quantum Computing)** **MIT OCW**
	• **edX and Coursera (Free audit options for tech courses)** **edX | Coursera**
	• **arXiv.org (Research papers on all emerging technologies)** **arXiv**

	MAM1072- Exploratory data analysis (EDA) using MS Excel SEC-Theory	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define key EDA concepts and MS Excel functions.	1
CO2	Explain data cleaning, preparation, and visualization techniques in Excel.	2
CO3	Apply Excel functions to analyze and visualize datasets.	3
CO4	Analyze datasets using advanced Excel tools and techniques.	4
CO5	Evaluate the quality of data and the effectiveness of analysis methods.	5
CO6	Create a comprehensive EDA project using MS Excel.	6

MAM1072- Exploratory data analysis (EDA) using MS Excel (SEC-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Introduction to EDA & Excel Basics** What is EDA? Importance and Objectives Introduction to MS Excel: Interface, Shortcuts, Basic Functions Data Types, Data Entry, and Formatting	**4**
II	**Data Cleaning & Preparation** Importing Data from Different Sources Handling Missing Data (IFERROR, ISNA, etc.) Data Validation, Removing Duplicates Text Functions (LEFT, RIGHT, MID, CONCATENATE) Using Flash Fill and Power Query	**6**
III	**Descriptive Statistics** Measures of Central Tendency: AVERAGE, MEDIAN, MODE Measures of Dispersion: STDEV, VAR, RANGE, QUARTILE Frequency Distribution and Binning (FREQUENCY, COUNTIF)	**5**
IV	**Data Visualization** Creating and Customizing Charts (Bar, Line, Pie, Scatter) Conditional Formatting for Insights Sparklines and Data Bars Pivot Tables and Pivot Charts Using Slicers and Timeline Tools	**6**
V	**Advanced Excel Functions for EDA** Lookup Functions: VLOOKUP, HLOOKUP, XLOOKUP Logical Functions: IF, AND, OR, IFERROR Statistical Functions: CORREL, COVAR, TREND Using Data Analysis ToolPak	**5**
VI	**Case Studies & Hands-on Practice (4 hours)** Real-world EDA Examples Hands-on Project: Analyzing a Dataset from Start to Finish Presentation of Findings	**4**

Learning Resources:

Sr. No.	References:
1	Analyzing Data with Microsoft Excel by Byron S. Gottfried
2	Excel 2019 Bible by Michael Alexander, Richard Kusleika (Available on Z-Library)
3	Exploratory Data Analysis in Business and Economics (Free with institutional access)
4	Microsoft Excel Step by Step (Available on Microsoft Learn)
5	Excel for Data Analysis (Free tutorials and resources)

	MAM1032- Probability Distributions **Minor-Theory**	
	Number of Credits: 02/04 **No. of Hours:30/60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define key concepts in probability theory.	1
CO2	Explain the key concept of random variables	2
CO3	Apply discrete and continuous distributions to implement in order to understand the concept.	3
CO4	Analyzing the concepts of probability theory	4
CO5	Evaluate the concepts of Probability Distributions	5
CO6	Implement the concepts to solve real life problems.	6

MAM1032- Probability Distributions
(Minor-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Discrete random variable:** Concept and definition of a discrete random variable Probability mass function (p.m.f.) and distribution function (d.f.), FX (·), of discrete random variable, expectation (mean) of a random variable, Definitions of variance, standard deviation (s.d.)	**2**
II	**Continuous Random Variable:** Concept and definition of a continuous random variable Probability density function (p.d.f.) and distribution function (d.f.), FX (·), of continuous random variable, Definition of expectation (mean) of a random variable, properties of expectation, expectation of a function of a random variable, Definitions of variance, standard deviation (s.d.)	**2**
III	**Special Discrete Distributions:** Discrete uniform distribution: p.m.f. mean and variance. Illustrations of real life situations where this distribution can be Applied Bernoulli distribution: p.m.f, mean, variance Binomial distribution: Notation X~B(n,p). p.m.f., mean and variance, additive property (derivations excluded). Illustrations of real life situations where the distribution can be applied. Computation of probabilities of events related to binomial r.v.	**10**
IV	**Standard Continuous Probability Distributions:** Uniform or rectangular distribution: probability density function (p.d.f.) , mean, variance Normal distribution: probability density function (p. d. f.) nature of probability curve, mean , variance, , computations of normal probabilities using normal probability integral tables,	**16**

	Exponential distribution: probability density function (p. d. f.) f (x) = α e - α x , x > 0 , α > 0 0 otherwise Notation : X ~ Exp(α) 2.6 Nature of p.d.f., mean, variance, m.g.f., c.g.f., d. f., graph of d. f., lack of memory property, median, quartiles. Distribution of min(X, Y) where X and Y are i.i.d. exponential r.v.s **Chi-square Distribution:** **Definition of chi-square (χ 2)** r. v. as sum of squares of i. i. d. standard normal variates, nature of probability. curve Computations of probabilities using tables of χ 2 distributions, mean, variance, Student's t distribution: Definition of student's t distribution with n d. f. where t = V / n U , U and V are independent random variables such that U ~ N(0, 1) , V ~ 2 χn , nature of probability curve, mean, variance, use of tables of t-distribution for calculation of probabilities, statement of normal approximation Definition of F r.v. with n1 and n2 d.f. as Fn , nature of probability curve, mean, variance, , use of tables of F-distribution for calculation of probabilities, Interrelations among, χ 2 , t and F variates.	

Learning Resources:

Sr. No.	References:
1	Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
2	Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
3	Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
4	Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
5	Medhi, J., Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002. 7. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

	MAM1042- Programming language - 2 **Minor-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the sequence data types in python	6
CO2	Discuss file handling for various types of files	5
CO3	Demonstrate python in built functions and data structures	4
CO4	Apply Oops concepts though Python	3
CO5	Determine the solution for a given problem by implanting various libraries	2
CO6	Integrating all the python features to solve the case studies.	1

MAM1042- Programming language - 2
(Minor-Practical)

Unit No.	Title of Unit and Contents	No. of hours
I	Overview - Recall data structures –Sequence data types and advanced programs	
II	**Files I/O and Modules -** File Handling, Attributes of File, Modes of File, File Handling Methods- What is a Module? Importing a Module, Built in Modules in Python, Package	
III	**Python-database Connectivity:** Establishing a Connection, CRUD (Create, Read, Update, Delete) Operations	
IV	**Object-Oriented Programming:** Class, Object, OOPs concepts – Polymorphism, Inheritance, Exception Handling, Abstraction, Encapsulation and Access Modifiers	
V	**Introduction to data processing and visualization:** Concept, Overview of the data processing, Various applications and branches, what is dataset? importing dataset, various sources of datasets, visualization – concept and use	
VI	**Python Libraries:** Overview of few important Python Libraries for data processing and visualization - NumPy, Pandas: importing dataset, dataframe, series different functions – Scikit-Learn etc, matplotlib	
VII	**Case Studies implementing python libraries**	

Learning Resources:

Sr. No.	References
1	Beginning-Python, Second Edition by Magnus LieHetland
2	The Complete Reference Python by Martin C.Brown
3	Headfirst Python by PatrickBarry
4	Learning Python, O'Reilly by MarkLutz
5	Python in a Nutshell, O'Reilly by AlexMartelli

	MAM1052- Data and databases **Minor-Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe major components of DBMS.	1
CO2	Interpret a problem and to recognize the computing requirements appropriate to its solution	2
CO3	Implement appropriate database for computer-based systems according to the user requirements, appropriate syntax to write SQL commands to perform various RDBMS operation	3
CO4	Analyse a problem to found out the computing requirements appropriate to its solution	4
CO5	Discuss the purpose of query processing for optimized solution	5
CO6	Design data requirements of an application with the help of conceptual modelling tools.	6

MAM1052- Data and databases
(Minor-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Database Management System Concepts:** Introduction, Significance of Database System Applications, Data Independence, Entities and their Attributes, Relationships and Relationship Types, E R Diagram, Data types, Creating tables (without keys)	
II	**Introduction to RDBMS:** Relational Database Management System, RDBMS Properties, Maintaining Integrity and Defining Data Integrity , Integrity Rules and Integrity Constraints, Relational Integrity Rules, Creating tables (with keys)	
III	**SQL:** Types of SQL DCL- DML, Basic queries in SQL Single table, Deletion- Insertion- and Update in SQL, Simple queries (with insert, delete, and update), Multi table Retrievals, Nested queries (with foreign key and using multi tables)	
IV	**Stored Functions**: Function definition How to write function and its execution, Solving some problems with function	
IV	**Stored Procedures:** Procedure definition, how to write procedure and its execution, Solving some problems with procedure	
V	**Cursors:** Cursor definition, how to write cursor and its execution, Solving some problems with cursor, Introduction to Triggers and Views	

Learning Resources:

Sr. No.	References
1	Henry F. Korth, Abraham Silberschatz, S. Sudarshan Database System Concepts, ISBN:9780071289597, Tata McGraw-Hill Education
2	KorryDouglas, PostgreSQL, , ISBN:9780672327568
3	John Worsley, Joshua Drake Practical PostgreSQL (B/CD), ISBN: 9788173663925 Shroff / O'reilly
4	Joshua D. Drake, John C Worsley Practical Postgresql, O'Reilly
5	Richard Stones, Neil Matthew Beginning Databases with PostgreSQL, From Novice to Professional, 2nd Edition

	MAM1062- Practical Data and Databases **Minor-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall SQL commands for table creation, alteration, and dropping with constraints.	1
CO2	Explain referential integrity and data consistency using primary and foreign keys.	2
CO3	Execute SQL queries for inserting, updating, and deleting records with constraints.	3
CO4	Differentiate and analyze simple vs. nested queries and set operations.	4
CO5	Assess SQL query efficiency using EXISTS and NOT EXISTS in nested queries.	5
CO6	Develop a database schema with ER diagrams, normalization, and complex queries.	6

MAM1062- Practical Data and Databases
(Minor-Practical)

Title of Experiment/ Practical	
1	Simple table creation, with only the primary key constraint (as a table level constraint & as a field level constraint) (include all data types)
2	Multiple tables creation with referential integrity constraint, Primary Key constraints
3	Tables creation with constraints - with Check, unique and not null etc., To drop a table from the database and to alter the schema of a table in the Database
4	Based on earlier assignments - insert / update / delete records
5	Simple select queries
6	Implementation of Set Operations
7	Use of 'Except', exists, not exists for Nested Queries
8	Simple and Nested query handling
9	Case Study I with ER Diagram
10	Case Study I with representation normalization