

# University of Mumbai

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विद्याविषयक प्राधिकरणे  
सभा आणि सेवा विभाग(ए.ए.एम.एस)  
कम नं. १२८ एम.जी.रोड, फोर्ट,  
मुंबई - ४०० ०३२  
टेलिफोन नं - ०२२ - ६८३२००३३

(नोंक पुनर्मुल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) राह अ++ श्रेणी  
विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ वर्जा)

क.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७

दिनांक : २७ मे, २०२५

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमलबजावणीच्या अनुषंगाने शैक्षणिक वर्ष २०२५-२६ पासून पदवी व पदव्युत्तर अभ्यासक्रम विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासक्रम मुंबई विद्यापीठाच्या [www.mu.ac.in](http://www.mu.ac.in) या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

मुंबई - ४०० ०३२  
२७ मे, २०२५

  
(डॉ. प्रसाद कारडे)  
कुलसचिव

क.वि.प्रा.स.से.वि/आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५  
Desktop/ Pritam Loke/Marathi Circular/NEP Tab Circular



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8	The Deputy Registrar, Executive Authorities Section (EA) <a href="mailto:eau120@fort.mu.ac.in">eau120@fort.mu.ac.in</a> He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
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# As Per NEP 2020

## University of Mumbai



### Syllabus for Major Vertical – 1 & 4

Name of the Programme – B.Sc. (Computer Science)

Faulty of Science

Board of Studies in Computer Science

U.G. Second Year Programme	Exit Degree	U.G. Diploma in Computer Science
Semester		III & IV
From the Academic Year		2025-26

# University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____	B.Sc. (Computer Science)
2	Exit Degree	U.G. Diploma in Computer Science
3	Scheme of Examination R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	Standards of Passing R: _____	40% in each component
5	Credit Structure Sem. III - R: SU-555C Sem. IV -R: SU- 555D	Attached herewith
6	Semesters	Sem III & IV
7	Program Academic Level	5.0
8	Pattern	Semester
9	Status	New
10	To be implemented from Academic Year	From Academic Year: 2025-26

Sd/-

**Sign of the BOS Chairman**  
**Dr. Jyotshna Dongardive**  
Ad-hoc BOS (Computer  
Science)

Sd/-

**Sign of the Offg.**  
**Associate Dean**  
**Dr. Madhav R. Rajwade**  
Faculty of Science & Technology

Sd/-

**Sign of Offg. Dean**  
**Prof. Shivram S. Garje**  
Faculty of Science &  
Technology

# Preamble

## 1) Introduction

The **Second Year** of the **B.Sc. Computer Science** program serves as a pivotal phase in the academic journey of students, deepening their understanding of both theoretical and applied aspects of computing. This stage is structured to strengthen their analytical thinking and programming abilities while introducing them to essential components of system-level programming, computational theory, and software development life cycles.

Core subjects such as **Data Structures**, **Operating Systems**, and the **Theory of Computation** form the backbone of this year, equipping students with skills to design efficient algorithms, understand system architecture, and explore the mathematical foundations of computing. Simultaneously, practical programming knowledge is enhanced through courses like **Java Programming**, which emphasizes object-oriented programming and GUI development, and **Computer Networks**, which provides an insight into data transmission, network protocols, and communication models.

An important aspect of this year is the inclusion of **Software Engineering** and **IoT Technologies**, which bridge theory with real-world application by guiding students through the structured development of software and embedded systems. Further, skill-oriented courses like **Mobile Application Development** and **MEAN Stack Development** expose students to industry-relevant tools and frameworks, fostering full-stack development and innovation.

Overall, this phase of the program is designed to shape students into competent problem solvers, capable of building scalable software solutions and understanding the internal workings of computing systems. It also encourages critical thinking, creativity, and a readiness to explore emerging technologies, laying a solid foundation for their final year of specialization and future career paths.

## 2) Aims and Objectives

**Deepen Conceptual Understanding:** To develop a strong conceptual understanding of intermediate-level topics such as Operating Systems, Theory of Computation, Computer Networks, and Software Engineering.

**Hands-on Skill Development:** To provide hands-on experience through practical labs in Data Structures, Java Programming, Mobile App Development, and IoT, encouraging students to apply their learning to solve real-world problems.

**Design & Analytical Skills:** To strengthen algorithmic and analytical skills, enabling students to design efficient data structures, evaluate system performance, and understand formal models of computation.

**Software Project Exposure:** To introduce students to structured software development processes, including requirement analysis, design, testing, and documentation using Software Engineering principles.

**Technology Familiarity:** To familiarize students with industry-relevant technologies such as MEAN stack and IoT to encourage innovation and interdisciplinary application.

**Teamwork & Communication:** To promote collaborative project work and improve communication skills through documentation and presentations, essential for industry-readiness.

### 3) Learning Outcomes

**By the end of the second year (S.Y.B.Sc.), students will be able to:**

- Design and implement efficient data structures and apply them in software applications.
- Explain the fundamental principles of Operating Systems, including process scheduling, memory management, and file systems.
- Demonstrate a clear understanding of formal languages, automata theory, and computational models in the Theory of Computation.
- Build dynamic and interactive Java-based applications, including GUI elements and object-oriented designs.
- Understand and describe how computer networks function, including the OSI and TCP/IP models, and apply this knowledge to network-based applications.
- Analyze and design software systems using Software Engineering methodologies such as the SDLC, UML diagrams, and requirement specifications.
- Develop IoT-based prototypes, integrating hardware and software for smart environments.
- Build simple mobile applications using industry-standard tools and frameworks.
- Implement full-stack web applications using MEAN Stack Development tools.
- Work collaboratively on lab assignments and mini-projects, exhibiting professionalism, communication skills, and teamwork.
- Prepare themselves for higher studies and internships by integrating theory with hands-on experience across varied domains of Computer Science. Formulate, model, and design solutions and procedures, utilizing software tools to address real-world problems effectively.

**Credit Structure of the Program  
Under Graduate Diploma in Computer Science**

<b>R: SU-555 C</b>										
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AE C, VE C, IKS	OJT, FP, CEP, CC, RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
5.0	III	MJ5: Principles of Operating Systems (TH) – 2	-	4	2	VSC:2  Java Programming – 2	AEC:2	FP: 2  CC:2	22	UG Diploma 88
		MJ6: Theory of Computation (TH) – 2								
		MJ7: Data Structures (TH) – 2								
		MJP3: Computer Science Practical 3 (PR) – 2								
	<b>8</b>									
<b>R: SU-555 D</b>										
5.0	IV	MJ8: Computer Networks (TH) – 2	-	4	2	SEC:2  Mobile Application Development – 2	AEC:2	CEP: 2  CC:2	22	
		MJ9: Software Engineering (TH) – 2								
	MJ10: IoT Technologies (TH) – 2	OR  MEAN Stack Development – 2								
		MJP4: Computer Science Practical 4 (PR) – 2								
		<b>8</b>								
	<b>Cum Cr.</b>	<b>28</b>	<b>-</b>	<b>10</b>	<b>12</b>	<b>6+6</b>	<b>8+4+2</b>	<b>8+4</b>	<b>88</b>	
<b>Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor</b>										

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Community Engagement Project, CC – Co-Curricular, RP – Research Project ]

## Semester III

Component	Major		Minor	OE	VSC	SEC	AEC	FP	CC	Total
	Mandatory	Electives								
Credits	2+2+2+2	---	4	2	2	---	2	2	2	22

Component	Subject	Total Credits
Major	Principles of Operating Systems	2
Major	Theory of Computation	2
Major	Data Structures	2
Major	Computer Science Practical 3	2
VSC	Java Programming	2

## Semester IV

Component	Major		Minor	OE	VSC	SEC	AEC	CEP	CC	Total
	Mandatory	Electives								
Credits	2+2+2+2	---	4	2	---	2	2	2	2	22

Component	Subject	Total Credits
Major	Computer Networks	2
Major	Software Engineering	2
Major	IoT Technologies	2
Major	Computer Science Practical 4	2
SEC (any one)	Mobile Application Development	2
	MEAN Stack Development	

**Sem – III**

## Name of the Course: Principles of Operating Systems

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Principles of Operating Systems course introduces students to the fundamental role an operating system plays in managing hardware and software resources. It covers essential concepts like process management, memory handling, file systems, and CPU scheduling, providing a strong foundation in how computers function at a low level.</p> <p><b>Relevance:</b></p> <p>This course is highly relevant as it bridges the gap between computer hardware and user applications. Understanding the operating system's role helps students grasp how various programs run efficiently and how resources like memory and CPU are allocated and managed.</p> <p><b>Usefulness:</b></p> <p>The course equips students with practical knowledge that is directly applicable in configuring, using, and troubleshooting different operating systems such as Linux, Windows, and macOS. It also deepens their understanding of how applications interact with system resources, which is critical for developers, testers, and IT professionals.</p> <p><b>Application:</b></p> <p>Operating system principles are used extensively in fields such as embedded systems, mobile application development, cloud computing, and cybersecurity. From smartphones to servers and IoT devices, the knowledge of OS design and implementation is central to building and maintaining modern computing environments.</p> <p><b>Interest:</b></p> <p>This course excites students by uncovering the inner workings of the systems they use every day. The hands-on aspects, like working with commands, simulating scheduling algorithms, and exploring file structures, make it both intellectually engaging and practically rewarding.</p> <p><b>Connection with Other Courses:</b></p> <p>The concepts learned here support and are reinforced in</p>

		<p>several other subjects such as Computer Architecture, Data Structures and Algorithms, System Programming, and Cybersecurity. The interdisciplinary nature of the course strengthens students' overall understanding of the computer science domain.</p> <p><b>Demand in the Industry:</b></p> <p>There is a consistent demand in the IT industry for professionals who understand the workings of operating systems. Tech companies developing system software, embedded platforms, or managing cloud infrastructure seek candidates who have a strong grasp of OS-level functioning.</p> <p><b>Job Prospects:</b></p> <p>Career opportunities after learning this subject include roles like system administrator, kernel developer, embedded systems engineer, and DevOps engineer. A deep knowledge of operating systems also opens doors to specialized fields such as cybersecurity, performance tuning, and system software development.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> To learn basic concepts and structure of operating systems</p> <p><b>CO 2.</b> To understand process communication techniques</p> <p><b>CO 3.</b> To study various CPU scheduling algorithms</p> <p><b>CO 4.</b> To learn about Memory management</p> <p><b>CO 5.</b> To learn about File system management and implementation</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Work with any type of operating system</p> <p><b>OC 2.</b> Handle threads, processes, process synchronization</p> <p><b>OC 3.</b> Implement CPU scheduling algorithms</p> <p><b>OC 4.</b> Understand the background role of memory management</p> <p><b>OC 5.</b> Design file system</p>	
9	<p><b>Modules:-</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Fundamentals of Operating systems</b> – Definition of Operating System, Operating System's role, Operating-System Operations, Functions of Operating System, Computing Environments Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, Operating-System Structure</p>	

	<p><b>Processes</b> – Threads - Overview, Multicore Programming, Multithreading Models, Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication</p> <p><b>Process Synchronization</b> – General structure of a typical process, race condition, The Critical-Section Problem, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors</p> <p><b>CPU Scheduling</b> – Basic Concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, SRTF, Priority, RR, Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling), Thread Scheduling</p>
	<p><b>Module 2 (15 hours):</b></p>
	<p><b>Deadlocks</b> – System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock</p> <p><b>Memory Management</b> – Main memory background, Logical address space, Physical address space, MMU, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table</p> <p><b>Virtual Memory</b> – Background, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Mass-Storage Structure: Overview, Disk Structure, Disk Scheduling, Disk Management</p> <p><b>File System Interface and Implementation</b> – File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management</p>
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Abraham Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley, 9<sup>th</sup> Edition</li> </ol>
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Achyut S. Godbole, Atul Kahate, Operating Systems, Tata McGraw Hill</li> <li>2. Naresh Chauhan, Principles of Operating Systems, Oxford Press</li> <li>3. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, 4e Fourth Edition, Pearson Education, 2016</li> </ol>
<b>12</b>	<p><b>Internal Continuous Assessment: 40%   Semester End Examination: 60%</b></p>

## Name of the Course: Theory of Computation

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Theory of Computation explores the fundamental principles that define what problems can be solved using computers and how efficiently they can be solved. It lays the groundwork for understanding computation through abstract machines, formal languages, and logical reasoning, making it a cornerstone of theoretical computer science.</p> <p><b>Relevance:</b></p> <p>This course is highly relevant as it forms the theoretical basis for designing algorithms, compilers, and programming languages. It deepens the student's understanding of the limits of computation, which is critical for solving complex computational problems systematically and effectively.</p> <p><b>Usefulness:</b></p> <p>The subject helps students learn how to model computational problems using mathematical tools and abstract machines like automata and Turing machines. These skills are vital when optimizing algorithms, designing new computing systems, or developing efficient parsing tools in programming languages.</p> <p><b>Application:</b></p> <p>Theory of Computation finds applications in compiler design, artificial intelligence, natural language processing, software verification, and cryptography. It also plays a key role in understanding whether problems can be solved algorithmically and what resources are required for their solutions.</p> <p><b>Interest:</b></p> <p>Students often find this subject intellectually stimulating because it challenges their logical and mathematical thinking. It involves elegant problem-solving techniques and creative ways to model and classify computational problems, sparking curiosity about the power and limits of machines.</p> <p><b>Connection with Other Courses:</b></p> <p>The course connects closely with subjects like Compiler Design, Artificial Intelligence, Algorithms and Data</p>

		<p>Structures, and Programming Language Theory. It provides the mathematical and logical foundation required for developing more advanced computer science concepts and tools.</p> <p><b>Demand in the Industry:</b></p> <p>Industries focused on algorithm development, formal verification, secure systems, and artificial intelligence highly value the principles taught in this course. Companies working in automation, language processing, and software correctness increasingly seek professionals with strong theoretical backgrounds.</p> <p><b>Job Prospects:</b></p> <p>Career opportunities include roles such as compiler engineer, language designer, research scientist, software developer, algorithm designer, and systems programmer. It also serves as a gateway for advanced studies or research in computer science, especially in theoretical and mathematical computing domains.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> Introduce the fundamental concepts of theoretical computer science, including automata theory, formal languages, and computational models.</p> <p><b>CO 2.</b> Understand the mathematical foundations necessary to describe and analyze computation.</p> <p><b>CO 3.</b> Explore different models of computation, including finite automata, pushdown automata, linear bound automata, and Turing machines.</p> <p><b>CO 4.</b> Analyze the decidability and complexity of computational problems.</p> <p><b>CO 5.</b> Introduce the theory of computability and the limitations of algorithmic solutions.</p> <p><b>CO 6.</b> Familiarize students with the classification of problems based on complexity classes such as P, NP, and NP-Complete.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Describe the fundamental concepts and significance of Theory of Computation in Computer Science.</p> <p><b>OC 2.</b> Design deterministic and non-deterministic finite automata for regular languages and prove their equivalence.</p>	

	<p><b>OC 3.</b> Apply regular expressions and grammars to define and generate formal languages.</p> <p><b>OC 4.</b> Construct context-free grammars and analyse their ambiguity, simplification, and normal forms.</p> <p><b>OC 5.</b> Differentiate between complexity classes such as P, NP, NP-Complete, and NP-Hard problems.</p> <p><b>OC 6.</b> Identify and analyze undecidable problems.</p>
<b>9</b>	<p><b>Modules</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to Theory of Computation:</b> Basics of Computation, Importance of Theory of Computation in Computer Science, Mathematical Foundations (Sets, Relations, Functions, Proof Techniques)</p> <p><b>Automata Theory:</b> Defining Automaton, Finite Automaton, Transitions and Its properties, Acceptability by Finite Automaton, Nondeterministic Finite State Machines, DFA and NFA equivalence, Mealy and Moore Machines, Minimizing Automata.</p> <p><b>Formal Languages:</b> Defining Grammar, Derivations, Languages generated by Grammar, Chomsky Classification of Grammar and Languages, Recursive Enumerable Sets, Operations on Languages, Languages and Automata</p> <p><b>Regular Languages:</b> Regular Grammar, Regular Expressions, Finite automata and Regular Expressions, Pumping Lemma and its Applications, Closure Properties, Regular Sets and Regular Grammar Context Free Languages: Context-free Languages, Derivation Tree, Ambiguity of Grammar, CFG simplification, Normal Forms, Pumping Lemma for CFG</p> <p><b>Module 2 (15 hours):</b></p> <p><b>Pushdown Automata:</b> Definitions, Acceptance by PDA, PDA and CFG</p> <p><b>Linear Bound Automata:</b> The Linear Bound Automata Model, Linear Bound Automata and Languages.</p> <p><b>Turing Machines:</b> Turing Machine Definition, Representations, Acceptability by Turing Machines, Designing and Description of Turing Machines, Turing Machine Construction, Variants of Turing Machine, Decidability and Undecidability, The Church-Turing thesis, Universal Turing Machine, Halting Problem, Introduction to Unsolvable Problems</p> <p><b>Computability and Complexity:</b> Time Complexity and Space Complexity, Big-O Notation, Class P and Class NP, NP-Complete and NP-Hard Problems, Polynomial Reductions, Introduction to Complexity Hierarchies</p>
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Theory of Computer Science, K. L. P Mishra, Chandrasekharan, PHI,3rd Edition</li> <li>2. Introduction to Computer Theory, Daniel Cohen, Wiley,2nd Edition</li> <li>3. Introductory Theory of Computer Science, E.V. Krishnamurthy,Affiliated East-West Press.</li> </ol>

<b>11</b>	<b>Reference Books</b> <ol style="list-style-type: none"><li>1. Theory of Computation, Kavi Mahesh, Wiley India</li><li>2. Elements of The Theory of Computation, Lewis, Papadimitriou, PHI</li><li>3. Introduction to Languages and the Theory of Computation, John E Martin, McGraw-Hill Education</li><li>4. Introduction to Theory of Computation, Michel Sipser, Thomson</li></ol>
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>   <b>Semester End Examination: 60%</b>

## Name of the Course: Data Structures

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>The Data Structures course introduces students to the foundational building blocks of programming and software development. It covers the systematic organization, management, and storage of data for efficient access and modification using various data structures.</p> <p><b>Relevance:</b></p> <p>Data structures are essential for solving computational problems efficiently, making this subject central to the study of computer science. Understanding how data is stored, manipulated, and accessed directly impacts the performance of applications.</p> <p><b>Usefulness:</b></p> <p>Knowledge of data structures allows students to choose the most appropriate structure for any problem, enabling optimal algorithm design and effective memory utilization. This leads to better program performance and scalability.</p> <p><b>Application:</b></p> <p>Data structures find wide applications in database indexing, compiler design, network routing, artificial intelligence, and graphics. Real-life scenarios such as job scheduling, expression evaluation, searching, and pathfinding extensively use stacks, queues, trees, and graphs.</p> <p><b>Interest:</b></p> <p>Students often find this subject intellectually stimulating as it challenges them to think logically and solve problems efficiently. Implementing structures like AVL Trees or graph traversals can be deeply engaging and rewarding.</p> <p><b>Connection with Other Courses:</b></p> <p>This course is closely linked with algorithms, operating systems, databases, and programming languages. Many advanced subjects assume a working knowledge of data structures, making it a prerequisite for deeper computer science learning.</p> <p><b>Demand in the Industry:</b></p> <p>Almost every tech role—from software development to system design—requires a strong understanding of data structures. Employers frequently test these concepts during technical interviews and coding assessments.</p>

		<b>Job Prospects:</b> Proficiency in data structures opens doors to careers in software engineering, data science, system architecture, web development, and cybersecurity. It provides a solid base for roles that involve designing efficient and scalable solutions.
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b> <b>CO 1.</b> To introduce students to the concept of Abstract Data Types (ADTs) and various data structures for efficient data representation and manipulation. <b>CO 2.</b> To develop an understanding of linked structures, including singly and doubly linked lists, and their applications. <b>CO 3.</b> To study stack and queue data structures, their implementation, and real-life applications like expression conversion and job scheduling. <b>CO 4.</b> To explore non-linear data structures such as trees and graphs, their operations, and their applications in problem-solving. <b>CO 5.</b> To understand the principles of priority queues, heaps, and hashing, and their role in efficient data access and management.	
8	<b>Course Outcomes (OC):</b> After successful completion of this course, students would be able to - <b>OC 1.</b> Define and implement various data structures using Abstract Data Types (ADTs) and understand their classifications and use cases. <b>OC 2.</b> Apply operations on linked lists, including traversal, insertion, deletion, and use them in practical applications like polynomial manipulations. <b>OC 3.</b> Implement stack and queue operations with array and linked representations, and apply them in real-world scenarios like delimiter checking and scheduling. <b>OC 4.</b> Design and traverse tree structures including binary trees, BSTs, AVL trees, and understand their applications in encoding and searching. <b>OC 5.</b> Implement graph structures, perform traversals using BFS and DFS, and solve shortest path and connectivity problems. <b>OC 6.</b> Use heaps and hashing techniques effectively for priority management, efficient searching, and collision handling in various applications.	
9	<b>Modules</b> <b>Module 1 (15 hours):</b> <b>Abstract Data Type:</b> Different Data Types, different types of data structures & their classifications, Introduction to ADT, Creating user-specific ADT <b>Linked Structures:</b> ADT for linked list, Advantages & Disadvantages, Singly Linked List-Traversing, Searching, Prepending and Removing Nodes, applications of	

	<p>linked list like polynomial equation, ADT of doubly linked list, Advantages &amp; Disadvantages, Insertion and deletion of nodes at various positions</p> <p><b>Stacks:</b> Stack ADT for Stack, Advantages &amp; Disadvantages, Applications of stack like balanced delimiter, prefix to postfix notation</p> <p><b>Queues:</b> Queue ADT, Advantages &amp; Disadvantages, linked representations. Circular Queue operations, Dequeues, applications of queue like job scheduling queues</p>
	<p><b>Module 2 (15 hours):</b></p> <p><b>Trees:</b> ADT for Tree Structure. Advantages &amp; disadvantages, Binary Tree-Properties, Implementation and Traversals, Binary Search Tree, Balanced BST, Threaded Binary Trees, AVL Trees, Applications of Tree like Huffman Coding,</p> <p><b>Priority Queues &amp; Heaps:</b> Priority Queue, Priority Queue ADT, Advantages and Disadvantages, Applications, Heaps, types of heaps, Heapifying the element,</p> <p><b>Graph:</b> Introduction, Graph ADT, Advantages and Disadvantages, Graph Representation using adjacency matrix and adjacency list, Graph operations like insertion and deletion of nodes, Graph Traversals using BFS &amp; DFS, Applications of Graphs like shortest path algorithms,</p> <p><b>Hashing:</b> Hash Table ADT, Advantages &amp; Disadvantages, Concept of hashing, hash table, hash functions, collision, collision avoidance techniques, Applications of hashing</p>
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Introduction to Algorithm, Thomas H Cormen, PHI</li> <li>2. Data Structures And Algorithms Made Easy, Narasimha Karumanchi, 2021</li> </ol>
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Fundamentals of Computer Algorithms, Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Universities Press, 2018</li> <li>2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2016</li> </ol>
<b>12</b>	<p><b>Internal Continuous Assessment: 40%</b>   <b>Semester End Examination: 60%</b></p>

## Name of the Course: Computer Science Practical 3

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>This course is a practical extension of theoretical concepts covered in Operating Systems and Data Structures. It introduces students to essential programming constructs required for system-level programming and structured data organization. Through carefully curated lab exercises, students gain insights into concurrency, resource management, scheduling, and structured data processing.</p> <p><b>Relevance:</b></p> <p>Operating Systems and Data Structures form the foundation of all computing systems and applications. Understanding how data is stored, accessed, manipulated, and how system resources are scheduled and synchronized is vital for every computer science graduate. This practical course equips students with essential skills that are applicable across all domains of software development and system programming.</p> <p><b>Usefulness:</b></p> <p>This course builds a strong foundation in system-level programming and abstract data handling, essential for any computer science graduate. It enhances the ability to understand and implement core concepts like scheduling, synchronization, and data abstraction through real-time coding tasks. Students gain valuable skills for debugging, memory management, and efficient algorithm design. These skills are crucial for both academic excellence and industry readiness.</p> <p><b>Application:</b></p> <p>The practical skills developed in this course are directly applicable in the design of operating system modules, file systems, and memory management tools. Data structures like trees, heaps, and graphs are widely used in building compilers, databases, and networking software. The understanding of multi-threading and process synchronization enables students to contribute to applications requiring concurrency, such as games, real-time simulations, and cloud systems. These applications form the backbone of modern software development.</p> <p><b>Interest:</b></p> <p>Students often find this course engaging due to its interactive and logic-based approach to solving real-world</p>

		<p>problems. Concepts like circular queues for task scheduling or graphs for social network analysis spark curiosity and hands-on involvement. The implementation of real-time synchronization and visual data traversals makes the learning process both stimulating and rewarding. This course encourages creative problem-solving through code.</p> <p><b>Connection with Other Courses:</b></p> <p>This practical course closely aligns with theoretical subjects like Operating Systems, Data Structures and Algorithms, and Object-Oriented Programming. It also forms the basis for advanced topics such as Distributed Systems, Artificial Intelligence, and Systems Programming. Concepts learned here are frequently reused and expanded upon in courses like Database Systems, Compiler Design, and Software Engineering. Hence, it serves as a vital link across the curriculum.</p> <p><b>Demand in the Industry:</b></p> <p>Industry consistently seeks professionals proficient in data structures and operating system fundamentals. Skills like process synchronization, memory optimization, and graph traversal are essential for roles in software development, cloud computing, and backend engineering. These competencies are tested during technical interviews at leading firms, including product-based and service-based companies. The ability to translate theoretical knowledge into efficient code is highly valued across tech domains.</p> <p><b>Job Prospects:</b></p> <p>Completing this course prepares students for roles such as Software Developer, System Programmer, Backend Engineer, or Technical Consultant. It opens opportunities in IT services, product development, and tech startups. With further specialization, students can also pursue careers in AI/ML, cybersecurity, and data engineering. The practical exposure provided here serves as a strong launchpad for core technical positions in the industry.</p>
<b>2</b>	<b>Vertical:</b>	Major
<b>3</b>	<b>Type:</b>	Practical
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 30 Hours of Practical work in a semester)
<b>5</b>	<b>Hours Allotted:</b>	60 hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks

7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To develop hands-on skills in implementing core concepts of operating systems and data structures.</p> <p><b>CO 2.</b> To simulate and solve real-world problems using process management, synchronization, and memory management.</p> <p><b>CO 3.</b> To strengthen students' understanding of data abstraction and manipulation using linked structures, trees, graphs, and hashing.</p> <p><b>CO 4.</b> To enable students to analyze and compare algorithmic strategies for CPU scheduling, buffer control, and structured data operations.</p> <p><b>CO 5.</b> To foster problem-solving abilities through coding, debugging, and testing of system-level and data structure-oriented programs.</p>
8	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Design and implement solutions using inter-process communication techniques such as shared memory and message passing.</p> <p><b>OC 2.</b> Apply multithreading, synchronization mechanisms, and scheduling algorithms to solve operating system-related problems.</p> <p><b>OC 3.</b> Construct and manipulate linear and non-linear data structures using custom implementations.</p> <p><b>OC 4.</b> Demonstrate effective use of stack, queue, trees, graphs, and hash tables in algorithm development.</p> <p><b>OC 5.</b> Analyze and evaluate the performance of memory and disk management techniques and abstract data operations.</p> <p><b>OC 6.</b> Apply practical programming knowledge to develop efficient, real-time, and scalable system-level applications.</p>
9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <hr/> <p><b>Practical based on Principles of Operating Systems</b></p> <hr/> <p><b>Process Communication using Shared Memory</b></p> <ul style="list-style-type: none"> <li>• Understand shared memory concepts in inter-process communication.</li> <li>• Implement producer-consumer synchronization using shared memory and semaphores.</li> <li>• Explore issues of race conditions and how to avoid them.</li> </ul> <p><b>Process Communication using Message Passing</b></p> <ul style="list-style-type: none"> <li>• Use message queues/pipes to solve the producer-consumer problem.</li> <li>• Compare and contrast shared memory vs. message-passing approaches.</li> <li>• Analyze blocking vs. non-blocking communication.</li> </ul> <p><b>Threading and Single Thread Control Flow</b></p> <ul style="list-style-type: none"> <li>• Practice thread creation and basic thread lifecycle using standard libraries (e.g., pthreads or Java threads).</li> </ul>

- Observe execution order, thread joining, and delays.
- Measure execution time for sequential vs threaded execution.

**Multi-threading and Fibonacci Generation**

- Implement multi-threading to generate and print Fibonacci sequences.
- Explore thread safety, synchronization when accessing shared variables.
- Introduce concepts of thread pooling and task delegation.

**Process Synchronization and Bounded Buffer Problem**

- Simulate producer-consumer bounded buffer using mutex and semaphores.
- Implement buffer control with synchronized access.
- Introduce circular queue techniques for managing shared buffers.

**Readers-Writers Problem – Synchronization in Shared Access**

- Implement reader and writer prioritization.
- Use semaphores to allow multiple readers or exclusive writer access.
- Extend to fairness in access and deadlock prevention.

**CPU Scheduling Algorithms (Part 1) – FCFS and Non-preemptive Scheduling**

- Simulate First-Come First-Serve scheduling.
- Extend implementation to general non-preemptive scheduling.
- Analyze waiting time, turnaround time, and Gantt chart generation.

**CPU Scheduling Algorithms (Part 2) – Round Robin**

- Implement Round Robin scheduling with configurable time quantum.
- Compare with FCFS: fairness, turnaround, response time.
- Track context switches and improve queue management.

**Memory Management Techniques**

- Simulate FIFO and LRU page replacement using page reference strings.
- Measure hit/miss ratios under different reference patterns.
- Extend to include frames and memory constraints.

**Disk Scheduling and Simple File System Design**

- Simulate FCFS, SSTF, C-SCAN, C-LOOK, RSS for disk head movement.
- Design a basic file system structure with block allocation, directory management, and file operations (create, read, delete).

**Module 2 (30 hours):**

**Practical based on Data Structures**

**Exploring Abstract Data Types (ADT) & Custom Structures**

- Create and manipulate structures to model ADTs like Student, Book, or

Employee.

- Implement basic operations (create, update, delete) using structures.
- Reflect on differences between primitive and abstract data types.

### **Building and Using Singly Linked Lists**

- Construct a dynamic singly linked list with basic operations.
- Apply linked lists to simulate scenarios such as managing a playlist or to-do list.
- Compare static (array) vs dynamic (linked) approaches.

### **Polynomial Operations Using Linked Lists**

- Represent polynomials using linked lists.
- Perform polynomial addition and subtraction by merging lists.
- Use structured representation to reinforce node manipulation.

### **Working with Doubly Linked Lists**

- Create a doubly linked list with forward and backward traversal.
- Implement insertion/deletion at head, tail, and specific positions.
- Use in scenarios like browser history or undo-redo features.

### **Implementing and Using Stack ADT**

- Implement push, pop, peek using arrays or linked lists.
- Solve problems like delimiter matching or undo mechanism.
- Convert expressions from prefix to postfix and evaluate them.

### **Understanding Queues and Circular Queues**

- Develop linear and circular queues to simulate task scheduling.
- Perform enqueue and dequeue with wrap-around logic.
- Discuss memory utilization in linear vs circular queues.

### **Tree Traversals and Binary Search Trees**

- Create a binary search tree (BST) from a dataset.
- Perform and visualize in-order, pre-order, and post-order traversals.
- Use traversal results to derive sorted sequences.

### **Balanced Trees & Priority Queues**

- Insert values and observe AVL tree rebalancing.
- Construct min-heaps or max-heaps and simulate priority queues.
- Use priority queues to manage task priorities (e.g., patient triage, job

	<p>scheduling).</p> <p><b>Graph Representations and Traversals</b></p> <ul style="list-style-type: none"> <li>• Represent graphs using adjacency matrices and lists.</li> <li>• Implement BFS and DFS to explore graph components.</li> <li>• Use graphs for mapping routes or exploring social networks.</li> </ul> <p><b>Hashing Concepts and Collision Handling</b></p> <ul style="list-style-type: none"> <li>• Implement a hash table with chaining or linear probing.</li> <li>• Simulate insertion, deletion, and search with collisions.</li> <li>• Discuss practical hashing applications (e.g., dictionary lookup, indexing).</li> </ul>
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Silberschatz, A., Galvin, P. B., &amp; Gagne, G. (2022). Operating system concepts (10th ed.). Wiley.</li> <li>2. Aho, A. V., Ullman, J. D., &amp; Lam, M. S. (2021). Data Structures and Algorithms in Python (Adapted by R. Rao). Pearson India.</li> </ol>
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Goodrich, M. T., Tamassia, R., &amp; Goldwasser, M. H. (2014). Data Structures and Algorithms in Java (6th ed.). Wiley India.</li> <li>2. Kanetkar, Y. (2020). Data Structures Through Python (1st ed.). BPB Publications.</li> </ol>
<b>12</b>	<p><b>Internal Continuous Assessment: 40%   Semester End Examination: 60%</b></p>

## Name of the Course: JAVA Programming

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>Java is one of the most widely-used, robust, and versatile programming languages in the software industry. It follows the object-oriented programming paradigm and is known for its platform independence, thanks to the Java Virtual Machine (JVM). This course introduces students to the foundational and advanced features of Java, covering core concepts, GUI development, multithreading, exception handling, web application development using Servlets and JSP, and database connectivity through JDBC.</p> <p><b>Relevance:</b></p> <p>In today's software-driven world, Java is a fundamental language that underpins many enterprise-level, web-based, mobile, and desktop applications. Its syntax and concepts are not only essential for programming in Java but also form the basis for understanding other languages such as C#, Kotlin, and Scala. Java's relevance is further reinforced by its use in Android development, big data (via tools like Hadoop), and large-scale enterprise applications.</p> <p><b>Usefulness:</b></p> <p>This course builds strong foundational skills in programming and software design. It enables students to construct modular programs using classes, interfaces, and packages. They also learn to handle exceptions, manage concurrent threads, design user-friendly graphical interfaces, and create dynamic, database-connected web applications using technologies like Servlets and JSP.</p> <p><b>Application:</b></p> <p>The practical aspect of the course allows students to build desktop tools, interactive GUI applications, and basic web portals. By working with JDBC, Swing, and multithreading, students gain hands-on experience in areas that mirror real-world software development scenarios.</p> <p><b>Interest:</b></p> <p>Java's simplicity, combined with its rich libraries and real-time problem-solving approach, makes learning</p>

		<p>engaging and rewarding. Students enjoy working on mini-projects, interactive applications, and seeing the immediate impact of their code, which deepens their interest and confidence in programming.</p> <p><b>Connection with Other Courses:</b></p> <p>The skills acquired in this course directly support and enhance learning in related subjects like Data Structures, Database Management Systems, Operating Systems, Web Development, and Software Engineering. It also forms a foundation for advanced electives in Mobile App Development and Enterprise Computing.</p> <p><b>Demand in the Industry:</b></p> <p>Java developers are in steady demand across industries such as finance, education, e-commerce, and healthcare. Its robustness, scalability, and extensive community support make it a preferred language for backend systems and enterprise-level applications.</p> <p><b>Job Prospects:</b></p> <p>After completing this course, students are well-prepared for internships and entry-level roles like Java Developer, Backend Developer, Software Engineer, Web Application Developer, and Android App Developer. Mastery of Java also positions students strongly for advanced certifications and competitive programming opportunities.</p>
<b>2</b>	<b>Vertical:</b>	VSC
<b>3</b>	<b>Type:</b>	Practical
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
<b>5</b>	<b>Hours Allotted:</b>	60 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> Provide a strong foundation in Java programming concepts including object-oriented principles and core syntax.</p> <p><b>CO 2.</b> Enable students to design and implement modular programs using classes, interfaces, packages, and exception handling.</p> <p><b>CO 3.</b> Introduce multithreading and collections to manage concurrency and structured data efficiently.</p> <p><b>CO 4.</b> Familiarize students with GUI development using Swing and event handling for desktop applications.</p> <p><b>CO 5.</b> Train learners to build web-based applications using Servlets, JSP, and JDBC for database connectivity and dynamic content.</p>	

8	<p><b>Course Outcomes (OC):</b>  After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Apply object-oriented programming concepts to develop efficient and maintainable Java applications.</p> <p><b>OC 2.</b> Implement exception handling and multithreading to build robust and concurrent programs.</p> <p><b>OC 3.</b> Use Java Collection Framework to store, manipulate, and retrieve data effectively.</p> <p><b>OC 4.</b> Design user interfaces using Swing components and handle user events in GUI applications.</p> <p><b>OC 5.</b> Connect Java applications with databases using JDBC and perform CRUD operations.</p> <p><b>OC 6.</b> Develop dynamic, session-managed web applications using Servlets and JSP.</p>
9	<p><b>Modules:</b></p> <p><b>Module (30 hours):</b></p> <p><b>Java Basics and OOP:</b> History and Features of Java, JVM, JDK, JRE, Java Program Structure, Tokens, Data Types, Operators, OOP Principles: Class, Object, Constructor, this, static, Inheritance, Polymorphism (Overloading/Overriding), Abstraction, Encapsulation, Abstract Classes, Interfaces, Inner Classes, super, Anonymous Classes</p> <p><b>Packages &amp; Access Specifiers:</b> Predefined &amp; user-defined packages, access specifiers</p> <p><b>Exception Handling:</b> Pre-Defined Exceptions, try-catch-finally, throw, throws, custom (user defined) exceptions</p> <p><b>Multithreading:</b> Thread creation, Thread life cycle, Synchronization, wait(), notify(), notifyAll()</p> <p><b>Collection Framework:</b> java.util overview, Interfaces: List, Set, Map, Classes: ArrayList, LinkedList, HashSet, TreeSet, HashMap</p> <p><b>Introduction to JSON:</b> Syntax, DataTypes, JSON with Java</p> <p><b>Module (30 hours):</b></p> <p><b>Java Foundation Classes &amp; Swing:</b> JFC Overview, Common Swing Components: JFrame, JPanel, JButton, JTextField, JLabel, Layouts, Event Handling using Delegation Event Model, Adapter classes, ActionListener</p> <p><b>JDBC:</b> JDBC Architecture &amp; Drivers, Connecting to DB, Statement, PreparedStatement, ResultSet, Navigating data, ResultSetMetaData, Transactions, Exception handling</p> <p><b>Servlets:</b> Servlet Lifecycle &amp; basic structure, Deployment Descriptor, ServletConfig, ServletContext, RequestDispatcher, Response redirection, Session tracking (Cookies, URL Rewriting, HttpSession), Introduction to Filter API</p>

	<p><b>Java Server Pages (JSP):</b> JSP Lifecycle &amp; Architecture, Scripting Elements, Directives, Implicit Objects, JSTL basics, Expression Language, CRUD operation overview using JSP</p> <p><b>JSON:</b> Syntax, DataTypes, JSON with Java</p>	
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Herbert Schildt, Java The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2020</li> <li>2. Bryan Basham, Kathy Sierra, Bert Bates, Head First Servlets and JSP, O'reilly (SPD), 2018</li> <li>3. Ivan Bayross, Web Enabled Commercial Applications Development Using Java 2, BPB Publications</li> <li>4. Java XML and JSON: Document Processing for Java SE by Jeff Friesen January 2019, Apress</li> </ol>	
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. E. Balagurusamy, Programming with Java- A Primer, Tata McGraw-Hill Education India, 2023</li> <li>2. Programming in JAVA, 2nd Ed, Sachin Malhotra &amp; Saurabh Choudhary, Oxford Press, 2018</li> <li>3. Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics, Thomson Course Technology (SPD)</li> <li>4. Eric Jendrock, Jennifer Ball, D Carson and others, The Java EE 5 Tutorial, Pearson Education</li> <li>5. Java Parsing Collection XML JSON: Map List XML JSON Transform by Yang Hu, 2019</li> </ol>	
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>

**Sem – IV**

## Name of the Course: Computer Networks

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Computer Networks course provides a foundational understanding of how computers and other devices communicate over various types of networks. It introduces key networking models like OSI and TCP/IP, explores the structure and functionality of different layers such as physical, data link, network, transport, and application, and dives into real-world protocols such as Ethernet, IP, TCP, HTTP, and DNS. The course also addresses modern developments like IPv6, Quality of Service (QoS), and secure communication practices.</p> <p><b>Relevance:</b></p> <p>In an era where connectivity drives innovation, understanding computer networks is essential for any computer science graduate. This course aligns with the growing need for professionals who can design, troubleshoot, and manage complex networked systems, including those used in cloud computing, data centers, mobile communications, and IoT environments.</p> <p><b>Usefulness:</b></p> <p>The course is highly useful for learners as it equips them with the theoretical background and practical insights needed to understand how data moves through networks. This knowledge is critical not only for roles in networking but also in software development, cybersecurity, systems administration, and IT infrastructure management.</p> <p><b>Application:</b></p> <p>Concepts learned in this course have direct application in configuring LANs and WANs, managing IP addresses, analyzing packet data, securing communications, and developing network-based applications. Students will be able to apply their knowledge in creating efficient, scalable, and secure communication systems.</p> <p><b>Interest:</b></p> <p>Students often find this course interesting due to its hands-on nature and immediate relevance to everyday technologies such as the internet, mobile phones, social media, and streaming services. Simulations and practical case studies help visualize how theoretical concepts apply</p>

		<p>in real-world network scenarios.</p> <p><b>Connection with Other Courses:</b></p> <p>This course connects closely with subjects such as Operating Systems, Database Management Systems, Web Programming, Cloud Computing, and Cybersecurity. A good understanding of networking is essential for understanding how distributed systems work, how servers handle requests, and how secure communication is maintained.</p> <p><b>Demand in the Industry:</b></p> <p>There is a consistent demand in the industry for professionals who understand networking principles and can manage network operations. Roles involving cloud platforms (like AWS, Azure), DevOps, and IT support all value networking skills. Knowledge of protocols and architectures is especially important for careers in network engineering, cybersecurity, and system integration.</p> <p><b>Job Prospects:</b></p> <p>Completing the Computer Networks course equips students for roles like network administrator, support technician, and system engineer. It builds a strong foundation for careers in cybersecurity, cloud computing, and IT infrastructure. The knowledge gained is valuable for industry certifications and in-demand across tech-driven sectors.</p>
<b>2</b>	<b>Vertical:</b>	Major
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> To introduce students to fundamental concepts of computer networks, network types, architecture, and models including OSI and TCP/IP.</p> <p><b>CO 2.</b> To explain data transmission techniques, bandwidth utilization, switching methods, and transmission media used in modern networks.</p> <p><b>CO 3.</b> To provide an understanding of data link layer functions including MAC, error detection/correction, and LAN protocols.</p> <p><b>CO 4.</b> To equip learners with knowledge of network layer operations such as IP addressing, routing, and protocol analysis including IPv4 and IPv6.</p>	

	<p><b>CO 5.</b> To introduce transport and application layer protocols and their real-world applications such as web communication, email, and DNS.</p> <p><b>CO 6.</b> To make students aware of modern network trends, QoS mechanisms, and the transition to IPv6 and secure communications.</p>
8	<p><b>Course Outcomes (OC):</b> After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Describe network architectures, types, models, and the layered approach in data communication.</p> <p><b>OC 2.</b> Analyze the working of physical and data link layers including signal transmission, media, error detection, and MAC protocols.</p> <p><b>OC 3.</b> Explain the role of switching techniques and multiplexing in efficient communication.</p> <p><b>OC 4.</b> Configure and evaluate IPv4/IPv6 addressing schemes and understand packet forwarding and routing algorithms.</p> <p><b>OC 5.</b> Compare and contrast TCP, UDP, and SCTP protocols and apply them to real-time applications.</p> <p><b>OC 6.</b> Use knowledge of application layer protocols (HTTP, FTP, Email, DNS, etc.) to understand client-server interactions.</p> <p><b>OC 7.</b> Assess Quality of Service (QoS) requirements and identify modern network challenges and solutions like 5G, satellite, and secure communication.</p>
9	<p><b>Modules:-</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to Computer Networks:</b> Networking standards and organizations (ISO, IEEE, IETF), Types of Networks: LAN, MAN, WAN, Network topologies and basic hardware</p> <p><b>Network Models:</b> OSI Reference Model – layers, functions, TCP/IP Protocol Suite – layers and comparison with OSI</p> <p><b>Physical Layer Concepts:</b> Data and signals: analog &amp; digital, Signal impairments: attenuation, noise, distortion, Data transmission: bandwidth, throughput, latency, Digital transmission: line coding, analog-to-digital conversion, Transmission modes: simplex, half-duplex, full-duplex</p> <p><b>Bandwidth Utilization &amp; Transmission Media:</b> Multiplexing: FDM, TDM, WDM, Spread Spectrum techniques: DSSS, FHSS, Transmission Media: Guided (Twisted Pair, Coaxial, Fiber Optics) &amp; Unguided Media (Radio, Microwave, Infrared)</p> <p><b>Switching Techniques:</b> Circuit Switching, Packet Switching (connectionless and connection-oriented)</p> <p><b>Data Link Layer and Error Handling:</b> Link layer addressing (MAC), framing concepts, Error detection: Parity, CRC, Checksum, Error correction: Hamming Code, Data link protocols: Stop-and-Wait, Go-Back-N, HDLC, Introduction to MAC: CSMA/CD, CSMA/CA</p>

	<p><b>Wired &amp; Wireless LANs:</b> Ethernet (standard, fast, gigabit). IEEE 802.11 Wi-Fi, Bluetooth, WiMAX, Cellular telephony: Generations overview (2G–5G), Satellite networks: types and applications</p>	
	<p><b>Module 2 (15 hours):</b></p>	
	<p><b>Network Layer Fundamentals:</b> Packet Switching Concepts, IPv4 Addressing, Subnetting, IP Packet forwarding &amp; routing, Overview of ICMPv4, Basics of Mobile IP</p>	
	<p><b>Routing Techniques:</b> Routing algorithms: Concepts of Distance Vector &amp; Link State Routing, Unicast Routing Protocols: Basic overview of RIP &amp; OSPF</p>	
	<p><b>IPv6:</b> IPv6 Addressing format, comparison with IPv4, ICMPv6, Transition strategies</p>	
	<p><b>Transport Layer Protocols,</b> Transport layer services, User Datagram Protocol (UDP), Transmission Control Protocol (TCP): Features, 3-way handshake</p>	
	<p><b>Application Layer &amp; Protocols:</b> Client-Server architecture: Iterative vs Concurrent Servers, Standard Protocols: HTTP (with HTTPS), FTP, Email (SMTP, POP3, IMAP), TELNET, SSH (modern replacement), DNS</p>	
	<p><b>Quality of Service (QoS):</b> Concepts of Delay, Jitter, Bandwidth, Flow control techniques, Integrated Services (IntServ) and Differentiated Services (DiffServ), Current trends: QoS in video streaming and VoIP</p>	
10	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Data Communications and Networking, Behrouz A. Forouzan, Fifth Edition, TMH, 2018.</li> <li>2. Computer Network, Andrew S. Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2018.</li> </ol>	
11	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Computer Network, Bhushan Trivedi, Oxford University Press, 2016</li> <li>2. Data and Computer Communication, William Stallings, PHI, 2017</li> </ol>	
12	<p><b>Internal Continuous Assessment: 40%</b></p>	<p><b>Semester End Examination: 60%</b></p>

## Name of the Course: Software Engineering

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>Software Engineering is the foundation for systematic software development. It introduces learners to the lifecycle of software—from planning and modeling to development and testing. The course provides a disciplined approach to creating software that meets user needs and performs reliably under real-world conditions.</p> <p><b>Relevance:</b></p> <p>In today’s digital age, software is integral to almost every sector. This subject is crucial as it prepares students to handle increasing software complexity and ensures they understand the importance of process-driven development and quality standards.</p> <p><b>Usefulness:</b></p> <p>The course equips students with practical tools and methodologies for planning, estimating, designing, and testing software. It fosters analytical thinking and technical communication, which are vital for handling real-life software projects effectively and efficiently.</p> <p><b>Application:</b></p> <p>Software Engineering principles are applied in various domains—banking, healthcare, education, mobile app development, and more. The skills learned here help in managing full-scale projects, ensuring user satisfaction and product scalability.</p> <p><b>Interest:</b></p> <p>The course offers engaging content like UML modeling, agile methods, risk management, and testing strategies. Students enjoy applying these concepts through diagrams, real-world case studies, and collaborative project planning.</p> <p><b>Connection with Other Courses:</b></p> <p>This subject ties well with courses in Object-Oriented Programming, Database Management, and Final Year Projects. It bridges theoretical knowledge with project execution skills, enhancing overall technical competence.</p> <p><b>Demand in the Industry:</b></p>

		<p>There is a high demand for software professionals who understand both development and project management. Agile development, DevOps, and software quality assurance are key skills sought by employers globally.</p> <p><b>Job Prospects:</b></p> <p>Completing this course opens doors to roles such as software developer, quality analyst, system designer, project assistant, and scrum team member. With experience, one can grow into roles like project manager, solution architect, or process consultant.</p>
<b>2</b>	<b>Vertical:</b>	Major
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> Provide foundational knowledge of software engineering processes, models, and methodologies.</p> <p><b>CO 2.</b> Introduce software requirements analysis and system modeling using UML.</p> <p><b>CO 3.</b> Explain software design principles, project estimation, and scheduling techniques.</p> <p><b>CO 4.</b> Familiarize students with software quality assurance, risk management, and configuration control.</p> <p><b>CO 5.</b> Enable understanding of software testing principles and test-case design techniques.</p>	
<b>8</b>	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Explain software process models and apply suitable models to project scenarios.</p> <p><b>OC 2.</b> Analyze software requirements and create UML-based system models.</p> <p><b>OC 3.</b> Apply design principles and estimation techniques for software development.</p> <p><b>OC 4.</b> Plan, schedule, and manage software projects effectively using industry practices.</p> <p><b>OC 5.</b> Demonstrate understanding of quality assurance and perform software testing using appropriate methods.</p>	

<p><b>9</b></p>	<p><b>Modules:-</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to Software Engineering:</b> Nature of Software, Software Engineering: Principles and Practice, Software Process Framework, Layered Technology, Process Framework, Process Patterns, Capability Maturity Model (CMM), Process Assessment</p> <p><b>Software Development Models:</b> Prescriptive Models: Waterfall, Incremental, Rapid Application Development (RAD), Evolutionary Models: Prototyping, Spiral Model, Specialized Models: Component-Based Development, Aspect-Oriented Development, Agile Development: Agile Manifesto, Extreme Programming (XP), Scrum Overview</p> <p><b>Requirements Engineering and Analysis:</b> Requirements Engineering Process, Elicitation Techniques (Interviews, Workshops, Use Cases), Components &amp; Characteristics of a Software Requirements Specification (SRS), Validation of Requirements</p> <p><b>System and Object-Oriented Modeling (using UML):</b> Use Case Diagram, Class Diagram, Sequence Diagram, Activity Diagram, State Chart Diagram, Component &amp; Deployment Diagram</p>
	<p><b>Module 2 (15 hours):</b></p> <p><b>Software Design and Architecture:</b> Design Principles: Coupling and Cohesion, Functional-Oriented vs. Object-Oriented Design, System Architecture Design, Design Verification and Validation, Monitoring and Control in Design</p> <p><b>Software Metrics and Estimation:</b> Software Measurement: LOC, Function Point, and Use Case-Based Estimations, Object-Oriented Metrics, Empirical Estimation Models, Introduction to COCOMO II, Estimation in Agile Development, Make/Buy Decision</p> <p><b>Software Project Management:</b> Project Planning: Scope, Feasibility, Resource Estimation, Project Scheduling: Effort Estimation, Time-Line Charts, Gantt Charts, Risk Management: Identification, Projection, RMMM Plan</p> <p><b>Software Quality Assurance &amp; Testing:</b> SQA Activities, Software Reviews, Formal Technical Reviews (FTR), Software Reliability and SQA Plan, Verification &amp; Validation, Testing Principles and Objectives, Test Oracles, Levels of Testing, White-box and Black-box Testing, Test Plan and Test Case Design</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Software Engineering, A Practitioner’s Approach, Roger S, Pressman, 2019</li> <li>2. Software Engineering: principles and Practices, Deepak Jain, OXFORD University Press, 2008</li> </ol>
<p><b>11</b></p>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Software Engineering, Ian Sommerville, Pearson Education, 2017</li> <li>2. Fundamentals of Software Engineering, Fourth Edition, Rajib Mall, PHI, 2018</li> </ol>

	3. Software Engineering: Principles and Practices, Hans Van Vliet, John Wiley & Sons, 2010
	4. A Concise Introduction to Software Engineering, Pankaj Jalote, Springer
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>   <b>Semester End Examination: 60%</b>

## Name of the Course: IoT Technologies

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Internet of Things (IoT) is an evolving field where devices connect and communicate to automate tasks and share data. This course lays the groundwork by explaining IoT's structure, history, key components, and its interaction with the internet and physical objects.</p> <p><b>Relevance:</b></p> <p>As industries shift toward automation and real-time analytics, understanding IoT has become vital for developing intelligent and connected systems. Its relevance spans domains like healthcare, agriculture, logistics, and smart cities.</p> <p><b>Usefulness:</b></p> <p>This course equips students with practical knowledge to create prototypes, interface sensors and actuators, and understand protocols. The hands-on exposure enhances the ability to design, implement, and troubleshoot IoT systems.</p> <p><b>Application:</b></p> <p>Students apply their knowledge in real-life scenarios such as environmental monitoring, smart homes, precision farming, and intelligent transportation systems. The course provides foundational skills to build IoT-based solutions from scratch.</p> <p><b>Interest:</b></p> <p>IoT offers an exciting blend of hardware, software, and communication, making it engaging for students who enjoy practical problem-solving. Working with microcontrollers and sensors adds a creative, hands-on dimension to learning.</p> <p><b>Connection with Other Courses:</b></p> <p>This course connects well with subjects like Embedded Systems, Computer Networks, Artificial Intelligence, Cloud Computing, and Mobile Application Development. It forms a practical bridge between theoretical concepts and real-world implementations.</p> <p><b>Demand in the Industry:</b></p>

		<p>The IoT market is booming with demand for professionals skilled in embedded programming, cloud integration, sensor interfacing, and data security. Industries are looking for people who can build, maintain, and scale IoT systems.</p> <p><b>Job Prospects:</b></p> <p>Students completing this course can explore roles like IoT Developer, Embedded Systems Engineer, Firmware Developer, IoT Solution Architect, and Application Developer. With further specialization, it opens doors to R&amp;D, automation, and innovation labs in industries across the globe.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> To introduce the fundamentals and evolution of IoT, including architecture and design principles.</p> <p><b>CO 2.</b> To explore various IoT platforms, sensors, actuators, and communication protocols.</p> <p><b>CO 3.</b> To impart knowledge of system-on-chip (SoC) architecture and interfacing techniques.</p> <p><b>CO 4.</b> To develop skills in building IoT systems and integrating them with web and cloud technologies.</p> <p><b>CO 5.</b> To create awareness about real-world IoT applications and current trends like Edge and Fog Computing.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Understand the core concepts, design, and architecture of IoT systems.</p> <p><b>OC 2.</b> Identify and use various sensors, actuators, and IoT development boards like Raspberry Pi, Arduino, and NodeMCU.</p> <p><b>OC 3.</b> Apply appropriate protocols for communication and ensure secure data exchange.</p> <p><b>OC 4.</b> Design simple IoT applications involving data collection, processing, and visualization.</p> <p><b>OC 5.</b> Analyze IoT use cases and appreciate the role of Edge, Fog, and Cloud in modern applications.</p>	

9	<p><b>Modules:-</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to IoT:</b> Definition, Characteristics &amp; Scope of IoT, History &amp; Evolution of IoT, IoT vs M2M, IoT Architectures (Three-layer, Five-layer), Physical &amp; Logical Design of IoT Systems, Enabling Technologies in IoT: Cloud Computing, Big Data, AI, Embedded Systems</p> <p><b>IoT Components &amp; Frameworks:</b> Smart “Things” and their identifiers, Overview of IoT Frameworks (Amazon AWS IoT, Google Cloud IoT, Azure IoT Hub)</p> <p><b>System on Chip (SoC):</b> What is SoC? Structure &amp; Characteristics, SoC Elements: FPGA, GPU, APU, Compute Units, Introduction to ARM and atmega328 Architectures</p> <p><b>IoT Hardware Platforms:</b> Overview and comparison: Raspberry Pi, Arduino, NodeMCU, IoT board capabilities, selection criteria for applications</p> <p><b>Hardware Interfacing &amp; Communication Protocols:</b> Basic components: LED, Button, Camera, Motor, 8×8 LED Grid, Communication protocols: PWM, UART, GPIO, I2C, SPI</p> <p><b>Module 2 (15 hours):</b></p> <p><b>Sensors &amp; Actuators:</b> Digital and Analog Sensors: Temperature, Humidity, Motion, Light, Gas, Ultrasonic, Interfacing Relay Switch, Servo Motor</p> <p><b>IoT Protocols &amp; Security:</b> Protocols: HTTP, MQTT, CoAP, XMPP, UPnP, Privacy and Security Issues in IoT</p> <p><b>Web &amp; Cloud Integration in IoT:</b> Web server setup for IoT, Data exchange with IoT device, Node-RED basics, Introduction to Cloud Platforms for IoT</p> <p><b>Wireless Sensor Networks (WSNs):</b> Basics, Architecture, Types, Role in IoT communication</p> <p><b>Edge &amp; Fog Computing:</b> Definition, Purpose and Use Cases, Edge vs Fog vs Cloud comparison, Edge architectures and communication models</p> <p><b>IoT Applications:</b> Case Studies in Healthcare, Agriculture, Transportation, Smart Cities</p>
10	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Introduction to IoT Paperback by Sudip Misra , Anandarup Mukherjee , Arijit Roy , Cambridge Press, 2022</li> <li>2. Jain, Prof. Satish, Singh, Shashi, “Internet of Things and its Applications”, 1st Edition, BPB, 2020.</li> <li>3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley, India, 2019</li> <li>4. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020</li> </ol>
11	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Internet of Things by Vinayak Shinde, SYBGEN Learning India Pvt. Ltd, 2020</li> </ol>

	<ol style="list-style-type: none"> <li>2. Internet of things, Dr. Kamlesh Lakhwani, Dr. Hemant kumar Gianey, Josef Kofi Wireko, Kamalkant Hiran, BPB Publication, 2020</li> <li>3. Arduino, Raspberri Pi, NodeMCU Simple projects in easy way by Anbazhagan k and Ambika Parameswari k, 2019.</li> <li>4. IoT based Projects: Realization with Raspberri Pi, NodeMCU Paperback – February 2020, by Rajesh Singh Anita Gehlot, 2020</li> <li>5. Mastering the Raspberri Pi, Warren Gay, Apress, 2014</li> </ol>		
<b>12</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;"><b>Internal Continuous Assessment: 40%</b></td> <td style="width: 50%;"><b>Semester End Examination: 60%</b></td> </tr> </table>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>
<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>		

## Name of the Course: Computer Science Practical 4

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b> This major practical course is a blend of two rapidly evolving areas in computing — Computer Networking and the Internet of Things (IoT). While the first part equips students with hands-on experience in network creation, routing, and traffic analysis, the second part transitions them into the world of intelligent connected devices. Students explore the design and deployment of smart systems using Raspberry Pi and Arduino kits, integrate sensors/actuators, and implement cloud-based interactions.</p> <p><b>Relevance:</b> This course is highly relevant in today’s digital world where interconnected devices and reliable communication networks form the backbone of every industry. The integration of Computer Networks and IoT ensures students gain comprehensive knowledge about both data communication and real-time embedded systems. As businesses and governments adopt automation and smart systems, professionals with expertise in both domains are in increasing demand.</p> <p><b>Usefulness:</b> The course equips students with practical skills to configure networks, interface hardware, and use protocols for communication and control. It bridges the gap between theory and practice by allowing learners to build, simulate, and test complete systems. These hands-on experiences enhance understanding and build a strong foundation for advanced learning or employment.</p> <p><b>Application:</b> The knowledge gained in this course can be directly applied to developing IoT systems like smart homes, environmental monitoring, health devices, and automated machinery. Students also learn to simulate network infrastructures and deploy routing protocols, which are essential in setting up enterprise-level networks. Real-world applications of this course span domains such as agriculture, transportation, education, and urban planning.</p> <p><b>Interest:</b> This course captures students’ interest through interactive hardware activities like blinking LEDs, controlling motors, and streaming sensor data. Tools like Cisco</p>

		<p>Packet Tracer, Node-RED, and Wireshark provide engaging visual and analytical insights into networking and IoT systems. Students are encouraged to innovate and experiment, keeping the learning experience dynamic and enjoyable.</p> <p><b>Connection with Other Courses:</b> The course complements core subjects such as Computer Networks, Microprocessor and Embedded Systems, Operating Systems, and Web Programming. It allows students to apply concepts from these theory courses in a practical setup, promoting interdisciplinary learning. The use of programming and cloud communication also ties into courses like Data Science and Cloud Computing.</p> <p><b>Demand in the Industry:</b> There is a significant and growing demand for professionals skilled in IoT and network technologies across industries such as healthcare, smart infrastructure, manufacturing, and IT services. Companies look for candidates who can develop, deploy, and maintain systems involving both physical hardware and software networking components. This course provides the skillset that aligns with industry trends and emerging technologies.</p> <p><b>Job Prospects:</b> Students completing this course are better prepared for roles such as IoT Developer, Network Administrator, Embedded Systems Programmer, and Cloud-IoT Integrator. They can work in sectors including telecom, automation, R&amp;D, and smart technologies. The practical skills gained make them suitable for both core technical roles and interdisciplinary project teams.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b>  <b>CO 1.</b> Develop hands-on proficiency in computer networking tools, commands, and simulation using Cisco Packet Tracer.  <b>CO 2.</b> Explore network topologies, routing protocols (RIP, OSPF, BGP), and IP addressing techniques (static/dynamic).  <b>CO 3.</b> Understand and apply various IoT communication protocols, platforms, and hardware interfaces using Raspberry Pi/Arduino.</p>	

	<p><b>CO 4.</b> Interface sensors, actuators, and edge devices for real-world IoT applications.</p> <p><b>CO 5.</b> Integrate hardware with software tools like Node-RED and cloud platforms for complete IoT solutions.</p>
<b>8</b>	<p><b>Course Outcomes (OC):</b> After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Use network diagnostic and configuration commands effectively on Windows and Linux systems.</p> <p><b>OC 2.</b> Design and simulate wired and wireless networks using Cisco Packet Tracer with IP configurations and routing protocols.</p> <p><b>OC 3.</b> Analyze network traffic using Wireshark and identify protocol layers and data flow.</p> <p><b>OC 4.</b> Configure and test IoT hardware platforms for device communication and data acquisition.</p> <p><b>OC 5.</b> Implement real-time IoT applications using sensors, actuators, and cloud communication.</p> <p><b>OC 6.</b> Develop integrated solutions using web technologies, IoT protocols, and dashboarding tools.</p>
<b>9</b>	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>Practical based on Computer Networks</b></p> <hr/> <p><b>Exploring Networking Commands via Windows CMD / LINUX Terminal</b></p> <ul style="list-style-type: none"> <li>Execute and observe the output of: ping, traceroute / tracert, netstat, arp, ipconfig / ifconfig, getmac, hostname, nslookup, pathping, systeminfo</li> <li>Discuss the purpose and interpretation of each command's output</li> </ul> <p><b>Learning Focus:</b> Understanding diagnostic and configuration commands.</p> <p><b>Building a Basic Peer-to-Peer Network</b></p> <p>Create a network with <b>two PCs</b> connected using a <b>crossover cable</b> using Cisco Packet Tracer</p> <ul style="list-style-type: none"> <li>Assign static IP addresses</li> <li>Test connectivity with ping and Packet Tracer simulation</li> </ul> <p><b>Static IP Setup with One Server and Two Clients</b></p> <p>Connect <b>1 server</b> and <b>2 computers</b> using a switch (Cisco Packet Tracer)</p> <ul style="list-style-type: none"> <li>Use <b>static IP addresses</b></li> <li>Configure server services (e.g., HTTP or FTP) and test connectivity from clients</li> </ul> <p><b>Dynamic IP Allocation with Server and Clients</b></p> <p>Use <b>DHCP service</b> from a server to assign IPs to <b>two PCs</b> (Cisco Packet Tracer)</p> <ul style="list-style-type: none"> <li>Enable and configure DHCP on the server</li> </ul>

- Verify IP allocation and connectivity using ipconfig

**Creating a Mixed Network with Wired and Wireless Devices**

One server, two wired PCs, and two **mobile/wireless devices** (Cisco Packet Tracer)

- Use appropriate cabling and access points
- Assign IPs and test cross-device communication

**RIP Version 1 Routing Across Three Routers**

Three routers, each connected to at least **three PCs** (Cisco Packet Tracer)

- Implement **RIPv1** routing between routers
- Verify inter-network connectivity using ping and route tables

**RIP Version 2 Implementation**

Three routers, each connected to at least **three PCs** (Cisco Packet Tracer)

- Enable **RIPv2** and observe subnet mask handling
- Use Packet Tracer’s simulation mode to observe routing updates

**OSPF Routing and Network Hierarchies**

Three routers and their networks using **OSPF**

(Three routers, each connected to at least **three PCs** (Cisco Packet Tracer)

- Assign area IDs, router IDs, and enable OSPF
- Monitor OSPF neighbour relationships and path selections

**BGP for Inter-domain Routing**

Three autonomous systems (AS) with routers running **BGP** Three routers, each connected to at least **three PCs** (Cisco Packet Tracer)

- Configure BGP with different AS numbers
- Establish peerings and test inter-AS communication

**Protocol Analysis with Wireshark**

- Set up network transactions for each protocol:  
ICMP (ping), TCP (web browsing), HTTP (via browser), UDP (DNS), FTP (file transfer)
- Apply filters and observe packet contents

**Module 2 (30 hours):**

**Practical based on IoT Technologies**

**Preparing the IoT Hardware**

- Set up Raspberry Pi OS / Arduino IDE
- Configure GPIO settings and test basic connectivity
- Demonstrate pin layout and onboard peripherals

### **GPIO – Light the LED (with and without Button)**

- Blink LED using Python (Raspberry Pi) or C++ (Arduino)
- Add a push button to toggle LED ON/OFF

### **SPI Interface – Camera Module Integration**

- Connect a Pi camera module (or SPI camera for Arduino)
- Capture an image or short video
- Store file or stream it locally

### **8x8 LED Grid Control (Matrix LED Programming)**

- Connect an 8×8 LED matrix module
- Program animations or scrolling text patterns
- Explore logical formulas for patterns

### **PWM – Stepper Motor Control**

- Interface a stepper motor using a motor driver
- Control direction and vary speed using PWM signals
- Observe effect of duty cycle changes on motor movement

### **Node-RED for IoT Dashboard**

- Install and configure Node-RED on Raspberry Pi
- Create a flow to turn LED ON/OFF via browser
- Add visual interface for sensor data (e.g., temperature)

### **Sensor Integration – Analog & Digital Sensors**

- Interface multiple sensors (LDR, DHT11, Gas)
- Collect and display data on serial monitor / OLED / LCD
- Trigger actions (e.g., fan ON if temp > threshold)

### **Web Trigger – Control GPIO from Web Server**

- Host a simple Flask web app (Raspberry Pi) or ESP Web Page (Arduino)
- Control a set of LEDs via buttons on a webpage
- Ensure real-time response and feedback

### **IoT Protocol – Send Sensor Data Online**

- Use HTTP or MQTT to push sensor values to a cloud server (e.g., Thingspeak)
- Implement publishing logic with timestamps
- Use Arduino/NodeMCU or Raspberry Pi as the publisher

	<p><b>Integration – Smart Monitoring System</b></p> <ul style="list-style-type: none"> <li>• Combine sensors, actuators, communication protocol, and web/cloud</li> <li>• Example: A Smart Weather Station that logs temp/humidity online and triggers fan/LED alerts</li> </ul> <p><i>Note: The above practicals can be performed on Raspberry Pi Kits and / or Arduino kits as per the need</i></p>	
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Kurose, J.F. &amp; Ross, K.W. (2021). <i>Computer Networking: A Top-Down Approach</i> (7th ed.). Pearson Education India.</li> <li>2. Ramya, V., &amp; Shanmuga Priya, K. (2019). <i>Practical Internet of Things: Concepts, applications and security</i>. Chennai: Wiley India Pvt. Ltd.</li> </ol>	
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Forouzan, B.A. (2017). <i>Data Communications and Networking</i> (5th ed.). McGraw Hill Education India.</li> <li>2. Bahga, A. &amp; Madisetti, V. (2014). <i>Internet of Things: A Hands-on Approach</i>. Universities Press India.</li> </ol>	
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>

## Name of the Course: Mobile Application Development

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>Mobile devices are ubiquitous in modern life, and with them comes the need for innovative and functional mobile applications. This course introduces students to the world of Android app development using Kotlin, the officially recommended programming language by Google. Learners get hands-on exposure to building real-time applications using Android Studio, enabling them to create robust, secure, and user-friendly mobile applications.</p> <p><b>Relevance:</b></p> <p>This course bridges academic programming knowledge with practical industry skills. In a world where mobile-first solutions dominate, Android development is one of the most sought-after technical skills, with Kotlin leading the trend due to its expressive syntax and reliability.</p> <p><b>Usefulness:</b></p> <p>This course provides hands-on experience with real-time Android app development using Kotlin, helping students bridge theoretical knowledge and practical application. Learners gain exposure to essential skills like UI design, database integration, and deployment practices, which are critical in the modern software development cycle.</p> <p><b>Application:</b></p> <p>Students can build interactive apps for domains like education, health, business, and entertainment. Through the use of features like Firebase, media handling, and location services, learners can design complete, data-driven mobile solutions suitable for real-world implementation.</p> <p><b>Interest:</b></p> <p>The course is engaging due to its visual and interactive nature — students see their code come to life in the form of functioning apps. Working with media, animations, sensors, and camera access makes the learning process exciting and creatively fulfilling.</p> <p><b>Connection with Other Courses:</b></p> <p>This course builds directly on programming concepts</p>

		<p>taught in Object-Oriented Programming and integrates well with Database Management Systems through SQLite and Firebase. It also relates to Software Engineering principles for structured app development and UI/UX Design for front-end aesthetics.</p> <p><b>Demand in the Industry:</b></p> <p>Android dominates the global mobile market, making Android app development a high-demand skill. With Google's backing of Kotlin, there is a rising need for developers proficient in this language, especially in the mobile-first product ecosystem.</p> <p><b>Job Prospects:</b></p> <p>Successful completion opens doors to roles like Android Developer, Mobile App Engineer, UI/UX Developer, and Firebase Backend Integrator. Students can also work as freelancers, contribute to startups, or launch their own apps on the Google Play Store.</p>
<b>2</b>	<b>Vertical:</b>	SEC
<b>3</b>	<b>Type:</b>	Practical
<b>4</b>	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted:</b>	60 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives (CO):</b></p> <p><b>CO 1.</b> Understand the fundamentals of mobile app development using Kotlin and Android Studio.</p> <p><b>CO 2.</b> Design and build interactive and responsive user interfaces for Android devices.</p> <p><b>CO 3.</b> Utilize core Android components such as Activities, Intents, and Fragments.</p> <p><b>CO 4.</b> Store, retrieve, and manipulate data using SQLite and Firebase Realtime Database.</p> <p><b>CO 5.</b> Implement multimedia, location-based, and background services in Android apps.</p> <p><b>CO 6.</b> Deploy and publish Android apps with proper versioning and signing protocols.</p> <p><b>CO 7.</b></p>	
<b>8</b>	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Set up Android Studio and develop basic Kotlin applications with UI interaction.</p> <p><b>OC 2.</b> Apply object-oriented programming concepts using Kotlin for mobile application logic.</p>	

	<p><b>OC 3.</b> Use core Android components to develop modular and multi-screen applications.</p> <p><b>OC 4.</b> Create dynamic UIs using layouts, fragments, menus, and handle user interactions efficiently.</p> <p><b>OC 5.</b> Store and retrieve data using local databases and cloud services like Firebase.</p> <p><b>OC 6.</b> Integrate media, camera, GPS, and background services into functional applications.</p> <p><b>OC 7.</b> Package, sign, and deploy Android applications to the Google Play Store.</p>
<b>9</b>	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>Getting Started with Android Studio &amp; Kotlin:</b> Setting up Android Studio, AVD, and first Kotlin-based app, Kotlin basics: variables, data types, type conversion, operators, Simple user input/output using TextView, EditText, Button</p> <p><b>Kotlin Control Flow &amp; OOP Basics in Action:</b> Control statements: if, when, loops, Functions, default arguments, extension functions, OOP concepts: classes, objects, inheritance, companion object</p> <p><b>Android Core Components:</b> Activities, Intents (explicit/implicit), Activity lifecycle: demo with logs and state changes, Fragments: modular UI creation, Toasts, Dialogs, and simple navigation</p> <p><b>Layout Design &amp; UI Interactions:</b> Layouts: Linear, Relative, ConstraintLayout, Views and UI Controls: TextView, EditText, Button, ImageView. Event handling: onClickListener, simple data validation, Styling UI: themes, styles, and manifest configuration</p> <p><b>Module 2 (30 hours):</b></p> <p><b>Working with Lists &amp; Menus:</b> ListView, RecyclerView, Adapter usage, Menus: options, context, and popup menus, Fragments with RecyclerView navigation</p> <p><b>Data Persistence &amp; Firebase Integration:</b> SharedPreferences, SQLite basics and CRUD operations, Firebase Realtime Database: read/write, rules, testing, Dynamic UI based on data</p> <p><b>Multimedia, Animations &amp; Camera Access:</b> Using ImageView, switching images, Playing audio using MediaPlayer, Simple animations with XML, Accessing device camera (capture &amp; display)</p> <p><b>Location, Background Tasks &amp; App Deployment:</b> Accessing location (GPS), Background tasks using JobScheduler, App signing and versioning, Deploying to Google Play (demo or mock submission)</p>
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. How to Build Android Apps with Kotlin: A hands-on guide to developing, testing, and publishing your first apps with Android, Alex Forrester, Packt Publishing, 2021</li> <li>2. Android Programming: Crafting UI/UX using Kotlin, SYBGEN Learning, 2020</li> </ol>

<b>11</b>	<b>Reference Books</b>	
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>

1. Head First Android Development: A Learner's Guide to Building Android Apps with Kotlin Dawn Griffiths, 3rd Edition, O'Reilly Media, 2021
2. Android Studio 4.2 Development Essentials - Kotlin Edition: Developing Android Apps Using Android Studio 4.2, Kotlin and Android Jetpack, Neil Smyth, Payload Media, 2021
3. Android Programming with Kotlin for Beginners, John Horton, Packt Publishing, 2019

## Name of the Course: MEAN Stack Development

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>MEAN Stack is a popular JavaScript-based technology stack used for developing full-stack web applications. It combines MongoDB (database), Express.js (backend web framework), Angular (frontend framework), and Node.js (runtime environment). The MEAN stack allows developers to use JavaScript throughout the application—on the front-end, back-end, and database layer—making development efficient and consistent.</p> <p><b>Relevance:</b></p> <p>With the increasing demand for cross-platform, real-time, and scalable applications, MEAN stack has emerged as a go-to technology for startups, enterprises, and product-based companies. This course addresses the industry need for developers skilled in full-stack JavaScript development, ensuring that learners stay up-to-date with modern tools and practices.</p> <p><b>Usefulness:</b></p> <p>The MEAN Stack course equips learners with the ability to build end-to-end web applications using JavaScript across all layers of development. It fosters an understanding of client-server communication, data flow, and modern design patterns, making learners self-sufficient developers. The unified use of JavaScript simplifies the learning curve and enhances productivity in real-world projects.</p> <p><b>Application:</b></p> <p>This course enables students to create responsive web applications such as e-commerce platforms, online booking systems, admin dashboards, social networking sites, and real-time chat apps. Learners can implement full-stack functionalities including database connectivity, routing, authentication, and RESTful services. It encourages building portfolio projects that demonstrate industry-relevant skills.</p> <p><b>Interest:</b></p> <p>The integration of hands-on labs, live coding sessions, and real-time application building keeps learners engaged and motivated. Learners experience immediate</p>

		<p>output and interactivity, which fuels curiosity and creative problem-solving. The modularity of the stack allows learners to explore each component deeply or specialize in their area of interest.</p> <p><b>Connection with Other Courses:</b></p> <p>This course complements earlier foundational subjects like HTML, CSS, JavaScript, Web Programming, and Database Management Systems. It serves as a bridge to advanced areas like Mobile App Development (using Ionic or React Native), Cloud Deployment, and DevOps. Students familiar with object-oriented programming and REST APIs will find a smooth transition into this full-stack course.</p> <p><b>Demand in the Industry:</b></p> <p>MEAN Stack development is widely adopted by startups and established firms alike due to its cost-efficiency and scalability. Employers are actively seeking developers with cross-functional abilities who can handle both frontend and backend tasks. With JavaScript being one of the most in-demand languages globally, MEAN Stack developers are highly valued in the job market.</p> <p><b>Job Prospects:</b></p> <p>Learners can pursue roles such as MEAN Stack Developer, Full Stack JavaScript Developer, Node.js Developer, Angular Frontend Developer, and API Developer. Opportunities are available in product development companies, IT consulting firms, SaaS platforms, and freelance markets. The skillset also serves as a foundation for launching independent software products or services.</p>
2	<b>Vertical:</b>	SEC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To provide a strong foundation in the MEAN (MongoDB, Express.js, Angular, Node.js) Stack for full-stack web development.</p> <p><b>CO 2.</b> To develop skills to build dynamic, data-driven web applications with server-side and client-side integration.</p>	

	<p><b>CO 3.</b> To introduce students to RESTful API development, routing, middleware, and database operations.</p> <p><b>CO 4.</b> To promote real-time application development using modern JavaScript frameworks and tools.</p> <p><b>CO 5.</b> To offer hands-on experience through mini-projects and practical implementation.</p>
<b>8</b>	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Design, develop, and deploy full-stack web applications using the MEAN stack.</p> <p><b>OC 2.</b> Build secure and scalable back-end APIs using Node.js and Express.js.</p> <p><b>OC 3.</b> Develop responsive and dynamic front-end interfaces using Angular.</p> <p><b>OC 4.</b> Perform CRUD operations in MongoDB using Mongoose.</p> <p><b>OC 5.</b> Integrate the front-end and back-end for seamless data flow and user experience.</p>
<b>9</b>	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>Introduction to MEAN Stack:</b> Understanding Full Stack Web Development, Overview of MEAN Architecture &amp; Workflow, Setting up the MEAN Development Environment</p> <p><b>Node.js Fundamentals:</b> Introduction &amp; Installation of Node.js, Understanding package.json &amp; npm, Node Modules &amp; Module Exports, Event Loop and Asynchronous Programming, Creating Basic Node.js HTTP Server, Handling Routes and Requests</p> <p><b>Express.js Framework:</b> Introduction to Express, Creating Express Applications, Using Middleware (Built-in, Custom, Third-party), RESTful Routing in Express, Creating API Endpoints (GET, POST, PUT, DELETE), Organizing Express Apps with Router Modules, Error Handling in Express, Environment Configuration using dotenv</p> <p><b>MongoDB with Mongoose:</b> Installing MongoDB and MongoDB Compass, Understanding Collections, Documents, Using Mongo Shell and MongoDB Compass. Introduction to Mongoose ODM, Defining Schemas &amp; Models, Performing CRUD Operations, MongoDB Validation &amp; Indexing Basics</p> <p><b>Introduction to Angular:</b> Installing Angular CLI &amp; Creating Angular App, Angular Project Structure, Anatomy of an Angular Component, One-way and Two-way Data Binding, *ngIf, *ngFor Directives, Using Services &amp; Dependency Injection, Component Communication (Input/Output decorators)</p> <p><b>Module 2 (30 hours):</b></p> <p><b>Angular Modules &amp; Routing:</b> Creating Feature Modules, Angular Routing: Setup and Navigation. RouterLink, RouterOutlet, Route Params, Lazy Loading of Modules</p>

	<p><b>Forms in Angular:</b> Template-driven vs Reactive Forms, Building Forms using Reactive Forms Module, Form Validation and Error Handling, Submitting Form Data to Backend APIs</p> <p><b>Connecting Angular to REST API:</b> HttpClientModule and Services, Making GET, POST, PUT, DELETE Requests, Displaying Server Data in Templates, Handling Observables and Async Pipe, Error Handling in HTTP Requests</p> <p><b>CRUD Application with Angular + Node + MongoDB:</b> Building a Complete CRUD App (e.g., Student Records / Notes App), Integrated Frontend and Backend, Form Validation and User Notifications, Deploying to Cloud (Vercel/Render for Backend, Netlify for Frontend)</p> <p><b>Introduction to Deployment:</b> Preparing Angular Build, Serving Angular App with Express (Single Deployment), Environment Variables and Production Setup, Introduction to Git and Version Control</p>
<b>10</b>	<p>Text Books</p> <ol style="list-style-type: none"> <li>1. Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications by Brad Dayley, Brendan Dayley, Caleb Dayley, Pearson, 2018.</li> <li>2. Full Stack Javascript Development with Mean - MongoDB, Express, AngularJS, and Node.JS by Adam Bretz, Colin J Ihrig, Shroff/SitePoint, 2015</li> </ol>
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Pro Mean Stack Development, Elad, Elrom, Apress, 2016</li> <li>2. Mastering MEAN Stack, Pinakin Ashok Chaubal, bpb, 2023</li> </ol>
<b>12</b>	<p><b>Internal Continuous Assessment: 40%   Semester End Examination: 60%</b></p>

## EVALUATION SCHEME

### A. Evaluation for Theory Courses (2 Credit Courses)

#### I. Internal Evaluation for Theory Courses – 20 Marks

a) for all courses other than Software Engineering course

Sr. No.	Component
1	<b>Class Tests</b>
	Class Test 1 on Module 1: 10 marks Class Test 2 on Module 2: 10 marks
	<b>Average of 2 Class Tests: 10 marks</b>
2	<b>Assignments</b>
	Assignment on Module 1: 5 marks Assignment on Module 2: 5 marks
	<b>Total of 2 Assignments: 10 marks</b>
	<b>Total: 20 Marks</b>

b) for Software Engineering course

**Select any one sample project\*** and prepare the following deliverables:

1. Problem Statement and SRS
2. DFD & Structured Chart
3. Use Case Diagram
4. Class Diagram, Object Diagram
5. State-chart & Activity Diagrams
6. Sequence Diagram, Collaboration Diagram
7. Component & Deployment Diagrams
8. Using Function Point (FP) Method
9. Gantt Chart / PERT Chart
10. Test Cases for Unit, Integration, White Box & Black Box Testing

Documentation: 10 marks
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Presentation: 10 marks
------------------------

<b>Total: 20 marks</b>
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\* *List of sample projects:*

- |                                     |                                    |
|-------------------------------------|------------------------------------|
| a. Student Result Management System | i. Automatic teller machine        |
| b. Library management system        | j. Video library management system |
| c. Inventory control system         | k. Hotel management system         |
| d. Accounting system                | l. Hostel management system        |
| e. Fast food billing system         | m. Share online trading            |
| f. Bank loan system                 | n. Hostel management system        |
| g. Blood bank system                | o. Resource management system      |
| h. Railway reservation system       | p. Court case management system    |

## II. External Examination for Theory Courses – 30 Marks

A Semester End Theory Examination of 1 hour duration for 30 marks as per the paper pattern given below:

**Total Marks: 30**

**Duration: 1 Hour**

Question	Based On	Options	Marks
Q. 1	Module 1	Any 2 out of 4	10
Q. 2	Module 2	Any 2 out of 4	10
Q. 3	Module 1 & 2	Any 2 out of 4	10

## B. Evaluation for Practical Courses (2 Credit Courses)

### I. Internal Evaluation for Practical Courses – 20 Marks

Sr. No.	Component
1	Practical Assignments / Experiments / Hands-On Tests / Presentations / Demonstrations / Online Class Test / Case Studies: 15 marks
2	Journal: 5 marks
	Total: 20 Marks

### II. External Examination for Practical Courses – 30 Marks

A Semester End Practical Examination of 2 hours duration for 30 marks as per the paper pattern given below.

**Total Marks: 30**

**Duration: 2 Hours**

Question	Practical Question Based On	Marks
Q. 1	Module 1	15
Q. 2	Module 2	15

1. **Certified Journal** is **compulsory** for appearing at the time of Practical Exam
2. Minimum **80% practical** are required to be completed.

## Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	----	Ab (Absent)	0

Sd/-  
**Sign of the BOS Chairman**  
**Dr. Jyotshna Dongardive**  
Ad-hoc BOS (Computer  
Science)

Sd/-  
**Sign of the Offg.**  
**Associate Dean**  
**Dr. Madhav R. Rajwade**  
Faculty of Science & Technology

Sd/-  
**Sign of Offg. Dean**  
**Prof. Shivram S. Garje**  
Faculty of Science &  
Technology

AC-20/05/2025

Item No.- 5.45 (N)

Sem-IV 5(a)

## As Per NEP 2020

### University of Mumbai



<b>Syllabus for Basket of AEC</b>	
<b>Board of Studies in English</b>	
<b>UG First Year B.sc Programme</b>	
<b>Semester</b>	<b>IV</b>
<b>Title of Paper</b>	<b>Credits</b>
<b>Introduction to Communication Skills in English II</b>	<b>2</b>
<b>From the Academic Year</b>	<b>2025-2026</b>

Sr. No.	Heading	Particulars
1	<b>Description of the course:</b> <b>Including but Not limited to:</b>	<b>Introduction to Communication Skills in English II</b> Effective academic communication skills are essential for success in scholarly pursuits. In the academic realm, proficiency extends beyond verbal articulation to encompass precise and coherent written expression. Students are not only required to engage in thoughtful discussions and articulate complex ideas verbally but must also demonstrate their understanding through well-crafted written assignments, and presentations. Academic communication involves the mastery of scholarly conventions, such as adherence to academic writing styles, and the ability to engage in dialogue with peers and scholars. It encompasses the skillful navigation of academic discourse, fostering an environment where ideas are shared, challenged, and refined. Developing strong academic communication skills empower individuals to contribute meaningfully to intellectual conversations, enriching both their academic journey and the broader scholarly community. This course with its 30:20 pattern will also help in accomplishing this goal. The course is aimed at honing their cognitive, analytical, linguistic and creative skills. It is hoped that by the end of the academic year, the learners will have developed confidence in using the English language both for oral and written communication as well as develop interest in enhancing these skills later on.
2	<b>Vertical:</b>	AEC (Ability Enhancement Course)
3	<b>Type:</b>	Theory
4	<b>Credit:</b>	2 credits (1credit=15Hours for Theory in a semester)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To cultivate a comprehensive understanding of English Usage in Communication</li> <li>2. To enhance reading proficiency with a diverse range of written texts with different genres and styles of written communication.</li> <li>3. To help learners with better comprehension of a variety of oral texts by inculcating listening skills through practical exercises.</li> <li>4. To train learners in group discussion and interview skills</li> <li>5. To provide practical experience in formal and creative writing.</li> </ol>

**8 Course Outcomes:**

At the end of the course the learner is able to:

- Demonstrate an understanding of English Usage in Communication
- Exhibit the ability to Read a variety of written text using subskills such as analyzing and interpreting text.
- Show competence in comprehending a variety of oral texts.
- Actively participate in group discussion, and research and prepare for the interview effectively
- Display advanced formal (email writing, report writing) and creative writing skills.

**9 Modules: -**

**Module1:(15 Lectures)**

**A) English Usage in Communication**

- Appropriacy in the Use of English
- Distinction between American English and British English
- Indianism and Indian English
- Elevator Pitch
- Modes and Types of Interview

**B) Enhancing Reading Competencies:**

- Augmenting active vocabulary
- Understanding relations between parts of a text
- Understanding concepts and arguments,
- Developing skills in analysis and interpretation
- Rewriting a passage from a defined perspective
- Reading critically (presenting a reasoned argument that evaluates and analyses what you have read)

A variety of passages of 200-250 words may be taken such as extracts from academic texts literary texts, magazines, newspapers, reports, documents. The passages should have complex text type, function and lexis. The learners may be encouraged to gather meaning contextually or by referring to offline and online sources such as dictionary, thesaurus, and encyclopedia.

**C) Listening Skills**

- Predicting content and guessing meaning
- Making inferences from the audio-visual text
- Listening for opinion/argument/counter-arguments etc.

- Taking notes

A variety of relevant audio/visual texts as samples may be drawn from various sources. Listening skills in English should be developed through various activities along with the practice done while teaching in the class.

**Module2: (15 Lectures)**

**A. Group Discussion**

- Formal and informal discussion
- Elements of group discussion
- Using appropriate language: Initiating, seeking and giving opinions, suggesting, responding to a suggestion, agreeing, disagreeing, interrupting, requesting, clarifying, summing up
- Types of discussion: Giving and sharing opinions of a given topic, making decisions, problem solving (case study)

**B. Interview Skills**

- Attending an Interview (Job/Entrance): Researching the organization, reviewing career-profile and your bio-data, preparing for standard questions, Responding to questions
- Analyzing Interviews

Students can be tested on forming actual interview frameworks including questions. Teachers must form the groups and conduct actual interviews involving full strength of students.

**C. Writing Skills:**

- Emails: applying for admission, accepting and joining (academic institution), Cancelling admission, registering a complaint
- Report Writing: Activity/Event report, Academic Report
- Creative Writing: Personal Essay, Memoir, Short Speech on the given occasion/ event, Story writing

**10** **Text Books: N.A.**

**11** **References:**

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Web link Resources:

1. A rendezvous with Simi Garewal: Ratan Tata:  
<https://www.youtube.com/watch?v=ozetTgOHu78&t=510s> Here Ratan Tata discusses his personal life, his expectations, his experience as a CEO of Tata and sons.
2. A rendezvous with Simi Garewal: Kiran Bedi: <https://youtu.be/vX2NyKvEAXQ> In this video, Kiran Bedi shares her daring adventures, her field, her passion for career with Simi Garewal.
3. In Conversation: Rajiv Mehrotra with J.R.D.Tata: <https://youtu.be/68otfg601HI> J. R. D. Tata discloses his dream of India, his experiences with Pandit Nehru, Mahatma Gandhi, Sardar Patel and his contribution to modern India.
4. The Tharoor Guide To Indian English: <https://youtu.be/NsyI9LIXbFM> Shashi Tharoor talks of new words like “defenstrate”, “brinjol”; talks about Indian English, ethnicity and so on.
5. Dr. A.P.J Abdul Kalam on Discovery, invention and innovation: <https://youtu.be/9CKCfiX3u00> Dr. Kalam addresses IIT Delhi students.
6. Malala Yousafzai’s speech on the occasion of her Nobel Peace Prize ( 2014) on education: <https://youtu.be/c2DHzkUI6s>
7. Kailash Satyarthi’s speech on the occasion of Nobel Peace Prize( 2014) on the innocence of children; he gives voice to voiceless in his speech: [https://youtu.be/wt0LSCeuc\\_M](https://youtu.be/wt0LSCeuc_M)
8. Speech by Mr. Ratan Tata: <https://youtu.be/m7-tKX7aZXM>
9. “I Have a Dream” speech by Martin Luther King Jr. HD (subtitled)  
<https://www.youtube.com/watch?v=vP4iY1TtS3s> “I Have a Dream” is a public speech that was delivered by American civil rights activist Martin Luther King Jr. during the March on Washington for Jobs and Freedom on August 28, 1963, in which he called for civil and economic rights and an end to racism in the United States.
10. Speech by Emma Watson on Gender Equality : <https://youtu.be/nIwU-9ZTTJc> 11. Imaginative science video: Could humans live in underwater cities?  
<https://youtu.be/GUGtU7Ii1yk>
12. A conversation about household appliances: <https://youtu.be/rAPI0fSborU> 13. Video on psychology: Why do we dream? <https://youtu.be/2W85Dwxx218>
14. Video on space: Solar system 101: <https://youtu.be/libKVRa01L8>
15. Video on evolution: How Apocalypses paved the way for Humans  
<https://youtu.be/libKVRa01L8> 16. Video on biology: Why Bats Aren't as Scary as You Think [https://youtu.be/D6e\\_qh3YRPs](https://youtu.be/D6e_qh3YRPs)
17. Video on social media: What is a social media influencer?  
<https://youtu.be/39A3og7enz8>
18. Tips on communication (TED Talk): The Secrets of Learning a New Language [https://youtu.be/o\\_XVt5rdpFY](https://youtu.be/o_XVt5rdpFY)

	<p>19. Expressing opinions: If Cinderella Were a Guy: <a href="https://youtu.be/p4OyCNctKXg">https://youtu.be/p4OyCNctKXg</a></p> <p>20. Telling stories without words: Partly Cloudy <a href="https://youtu.be/ix13P9NqBjo">https://youtu.be/ix13P9NqBjo</a></p> <p>21. Telling stories without words: Tree of Unity <a href="https://youtu.be/sAo41Gyl6hY">https://youtu.be/sAo41Gyl6hY</a> 17</p> <p>22. Bonding over the Radio: A special storytelling series by the much loved author Ruskin Bond: akashvaniair <a href="https://youtu.be/oxf60BIR2Q4">https://youtu.be/oxf60BIR2Q4</a> <a href="https://youtu.be/ISX7rUOJOms">https://youtu.be/ISX7rUOJOms</a> <a href="https://youtu.be/rrC_s0XPXKI">https://youtu.be/rrC_s0XPXKI</a> <a href="https://youtu.be/FUML3q1ncF0">https://youtu.be/FUML3q1ncF0</a> <a href="https://youtu.be/3by_ninqRzg">https://youtu.be/3by_ninqRzg</a></p> <p>23. Video on the English language: Where did English come from? <a href="https://youtu.be/YEaSxhcns7Y">https://youtu.be/YEaSxhcns7Y</a></p> <p>24. Video on biology: The science of skin colour: <a href="https://youtu.be/r4c2NT4naQ">https://youtu.be/r4c2NT4naQ</a></p> <p>25. Video on advertising: The Science of Persuasion <a href="https://youtu.be/cFdCzN7RYbw">https://youtu.be/cFdCzN7RYbw</a></p> <p>26. "The Happy Prince" Oscar Wilde Michael Mills Classic Animated Short 1974 <a href="https://www.youtube.com/watch?v=q3RZh1yaqxM">https://www.youtube.com/watch?v=q3RZh1yaqxM</a> Learners may be encouraged to watch animated stories such as this one and questions asked later on.</p>	
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>
<b>13</b>	<p><b>Continuous Evaluation through:</b></p> <ul style="list-style-type: none"> <li>• Performance in activities on Module 2 A &amp; B during lectures: (10 marks) The class may be divided into batches to participate in Group Discussion and mock interview by creating formal schedule for the same before the semester End Examination.</li> <li>• Participation in classes during lectures: (05 marks) (Learners' response during the teaching and the tasks involving Listening skills (Module 1 C) will be assessed)</li> <li>• Overall attendance in lectures (05 marks) (Percentage of learners' attendance in class to be considered)</li> </ul>	
<b>14</b>	<p><b>Format of Question Paper:</b> for the final examination</p> <p>Q.1. Short Notes on Module 1 A (2 out of 4) 10 Marks</p> <p>Q.2. Unseen Passage (200-250 words) ( Module 1 B) 10 Marks</p> <p>Q.3 Writing Skills on Module 2 C – Writing an email or a Report or Creative Writing 10 Marks</p>	

**Sd/-**  
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**Dr. Sachin Labade**  
**Board of Studies in**  
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**Humanities**

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**Prof. Dr. Anil Singh**  
**Faculty of**  
**Humanities**

AC – 20/05/2025  
Item No. – 5.45 (N) Sem-III 2(a)

## As Per NEP 2020

### University of Mumbai



<b>Syllabus for Marathi - AEC</b>	
<b>Board of Studies in Marathi</b>	
<b>UG Second Year Programme</b>	
<b>Semester</b>	<b>III</b>
<b>Title of Paper</b>	<b>लेखन कौशल्ये -२ (महाजालावरील लेखन)</b>
<b>Credits</b>	<b>2</b>
<b>From the Academic Year</b>	<b>2025-26</b>

**Syllabus**  
**B.A. (Marathi AEC)**  
**(Semester - III)**

**Title of Paper : लेखन कौशल्ये - २ (महाजालावरील लेखन)**

Sr. No.	Heading	Particulars
1.	<b>अभ्यासक्रमाचे वर्णन : (Description of the Course )</b>	<p>राष्ट्रीय शैक्षणिक धोरण - २०२० विद्यार्थ्यांच्या सर्वांगीण विकासावर (Wholistic Development) भर देते. या धोरणात सर्वांगीण विकासाचा भाग म्हणून क्षमता वर्धन अभ्यासक्रम (Ability Enhancement Course) या स्तंभांतर्गत भाषिक कौशल्य अभ्यासक्रमाचा समावेश करण्यात आला आहे. कला, वाणिज्य व विज्ञान या विद्याशाखांमध्ये अध्ययन करणाऱ्या विद्यार्थ्यांना तिसऱ्या सत्रामध्ये 'आधुनिक भारतीय भाषां'चे अध्ययन अनिवार्य करण्यात आले आहे. सदर क्षमता वर्धन अभ्यासक्रमाचे स्वरूप प्रामुख्याने भाषाकेंद्री असावे, असेही राष्ट्रीय शैक्षणिक धोरणात नमूद करण्यात आले आहे. विद्यार्थ्यांना विविध प्रकारच्या भाषिक कौशल्यांचा तपशीलवार परिचय करून देणे, तसेच ती कौशल्ये आत्मसात करण्याची संधी विद्यार्थ्यांना उपलब्ध करून देणे, ही या अभ्यासक्रमाची महत्त्वाची उद्दिष्टे आहेत. ही उद्दिष्टे लक्षात घेऊन 'लेखन कौशल्ये - २ (महाजालावरील लेखन)' (श्रेयांकने २) या अभ्यासपत्रिकेची आखणी करण्यात आली आहे.</p> <p>आंतरमहाजाल हे एकविसाव्या शतकातील अत्यंत प्रभावी साधन आहे. जगभरातील संगणक एकमेकांशी जोडले जाऊन त्यांचे जाळे तयार झाले आहे. विविध सामाजिक माध्यमस्थळांवर स्वतःचे खाते (अकाउंट) तयार करणे आणि त्यावर मराठी भाषा व देवनागरी लिपीतून लिहिणे, ही समकालीन संपर्क व्यवहारातील आवश्यक बाब झाली आहे. यास अनुसरून आपल्या अभिव्यक्तीला व्यासपीठ मिळवून देणारी अनुदिनी (ब्लॉग) तयार करणे, विकिपीडियावर भोवतालातील भाषा, साहित्य, संस्कृतीशी निगडित माहितीपर व विश्लेषणात्मक नोंदी लिहिणे, सामाजिक माध्यमस्थळांवरील आपल्या खात्यावर सातत्याने अभ्यासपूर्ण लेखन करणे, स्वक्षमतेशी निगडित समाजगट / आभासी कट्टे (कम्युनिटी ग्रुप) तयार करणे, या बाबींसाठी आवश्यक सामाजिक माध्यमस्थळ साक्षरता आणि मराठी भाषा व देवनागरी लिपीतून लिहिण्याची क्षमता 'लेखन कौशल्ये - २ (महाजालावरील लेखन)' (श्रेयांकने २) या अभ्यासपत्रिकेच्या अध्ययनातून विद्यार्थ्यांमध्ये निर्माण होईल.</p>

2.	<b>Vertical</b>	Ability Enhancement Course
3.	<b>Type</b>	Theory
4.	<b>Credit</b>	2 Credits (1 Credit = 15 Hours for Theory or 30 Hours of Practical Work in a Semester)
5.	<b>Hours Allotted</b>	30 Hours (AEC या स्तंभांतर्गत शिकविल्या जाणाऱ्या अभ्यासपत्रिकांच्या कार्यभारासंबंधी मुंबई विद्यापीठाच्या दिनांक २३ जुलै, २०२४ च्या NO.AAMS_UGS/ICC/2024-25/19 या परिपत्रकाचा आधार घ्यावा.)
6.	<b>Marks Allotted</b>	50 Marks
7.	<b>अभ्यासक्रम उद्दिष्टे (Course Objectives) :</b> १. महाजालावरील लेखन कौशल्याचे स्वरूप समजावून सांगणे. २. महाजालावर प्रभावी लेखन करण्यासाठी आवश्यक असणाऱ्या तंत्रांचा परिचय करून देणे. ३. नेहमीच्या पठडीतील लेखन व महाजालावरील लेखन यांमधील साम्य-भेद स्पष्ट करणे. ४. विविध सामाजिक माध्यमस्थळांवर लेखन करण्यासाठी आवश्यक कौशल्ये व क्षमता विकसित करणे.	
8.	<b>अभ्यासक्रम निष्पत्ती (Course Outcomes) :</b> १. विद्यार्थ्यांना महाजालावरील लेखन कौशल्याचे स्वरूप समजेल. २. विद्यार्थ्यांना महाजालावर प्रभावी लेखन करण्यासाठी आवश्यक तंत्रांचा परिचय होईल. ३. विद्यार्थ्यांना नेहमीच्या पठडीतील लेखन व महाजालावरील लेखन यांमधील साम्य-भेद स्पष्ट होईल. ४. विद्यार्थ्यांमध्ये विविध सामाजिक माध्यमस्थळांवर लेखन करण्यासाठी आवश्यक कौशल्ये व क्षमता विकसित होतील.	
9.	<b>अभ्यासघटक (Module) :</b>	
	<b>घटक - १ : सामाजिक माध्यमस्थळांवर मराठी भाषा व देवनागरीतून लेखन (भाग - १)</b>	
	अ) अनुदिनी (ब्लॉग) लेखन आ) विकिपीडियावरील लेखन (६० मिनिटांच्या १५ तासिका, श्रेयांकन १)  (सूचना : विद्यार्थ्यांमध्ये उपरोक्त सामाजिक माध्यमस्थळांवर लेखन करण्यासाठी आवश्यक कौशल्ये व क्षमता विकसित होतील या दृष्टीने शिक्षकांनी सराव करून घ्यावा.)	

<b>घटक -२ : सामाजिक माध्यमस्थळांवर मराठी भाषा व देवनागरीतून लेखन (भाग - २)</b>	
<p>अ) फेसबुक, इन्स्टाग्राम, एक्स यांवरील लेखन  आ) समाज गट (कम्युनिटी ग्रुप), आभासी कट्टे यांवरील लेखन  (६० मिनिटांच्या १५ तासिका, श्रेयांकन-१)</p> <p>(सूचना : विद्यार्थ्यांमध्ये उपरोक्त सामाजिक माध्यमस्थळांवर लेखन करण्यासाठी आवश्यक कौशल्ये व क्षमता विकसित होतील या दृष्टीने शिक्षकांनी सराव करून घ्यावा.)</p>	
<b>10.</b>	<b>पाठ्य ग्रंथ (Text books) : N. A.</b>
<b>11.</b>	<p><b>संदर्भ ग्रंथ (Reference Books) :</b></p> <p>१. मराठी व्याकरण आणि लेखन, विनायक गंधे व मीरा जोशी, निराली प्रकाशन, पुणे, २०१२.  २. उपयोजित मराठी, (संपा.) केतकी मोडक व अन्य, पद्मगंधा प्रकाशन, पुणे, २०१२.  ३. मराठी भाषिक कौशल्य विकास, (संपा.) पृथ्वीराज तौर, अथर्व पब्लिकेशन्स, धुळे, २०१८.  ४. व्यावहारिक मराठी, ल. रा. नसिराबादकर, भाषा विकास संशोधन संस्था, कोल्हापूर, २०२३.  ५. <i>Aayushi International Interdisciplinary Research Journal</i> (ISSN 2349-638x) Peer Reviewed Journal <a href="http://www.aiirjournal.com">www.aiirjournal.com</a></p>
<b>12.</b>	<p><b>Internal Continuous Assessment : 40%</b></p> <p><b>External, Semester End Examination : 60% Individual Passing in Internal and External Examination</b></p>
<b>13.</b>	<p><b>अंतर्गत सातत्यपूर्ण मूल्यांकन (Internal Continuous Assessment) : २० गुण</b></p> <p><b>अंतर्गत मूल्यांकनाचे स्वरूप (Format of Internal Assessment) :</b></p> <p>चाचणी परीक्षा / मौखिक परीक्षा / प्रकल्पलेखन / नियतकार्य (Assignment) / सादरीकरण / प्रश्नमंजूषा यांपैकी कोणत्याही पद्धतींचा अवलंब करून अंतर्गत मूल्यमापन करता येईल.  (प्रत्यक्ष उपस्थिती किंवा ऑनलाईन)</p>

14. बहिरगत परीक्षा (External Examination) : ३० गुण (वेळ : एक तास)

बहिरगत परीक्षेच्या प्रश्नपत्रिकेचे स्वरूप (Format of Question Paper) :

१. प्रत्येकी १५ गुणांचे एकूण तीन प्रश्न विचारावेत. त्यांपैकी विद्यार्थ्यांनी कोणतेही दोन प्रश्न सोडवावेत.
२. पहिले दोन प्रश्न दीर्घोत्तरी स्वरूपाचे असावेत. दोन्ही घटकांवर आधारित १५ गुणांचे अंतर्गत पर्याय असलेले दोन प्रश्न विचारावेत.
३. तिसरा प्रश्न हा घटक क्रमांक एक व दोनवर आधारित १५ गुणांचा वस्तुनिष्ठ स्वरूपाचा असावा. प्रत्येक घटकावर दहा याप्रमाणे एकूण वीस प्रश्न विचारावेत. विद्यार्थ्यांनी कोणतेही पंधरा प्रश्न सोडवावेत.

Sd /-

Sign of the BOS  
Chairman  
Prof. Dr. Satish  
Kamat  
Board of Studies in  
Marathi

Sd/-

Sign of the  
Offg. Associate Dean  
Dr. Suchitra Naik  
Faculty of  
Humanities

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Sign of the  
Offg. Associate Dean  
Prof. Manisha  
Karne  
Faculty of Humanities

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Offg. Dean  
Prof. Anil Singh  
Faculty of  
Humanities

## As Per NEP 2020

# University of Mumbai



### Syllabus for Basket of OE Vertical 3

<b>Syllabus for Basket of OE Vertical 3</b>	
<b>Faculty of Science</b>	
<b>Board of Studies in Statistics</b>	
<b>UG Second Year Programme</b>	
<b>Semester</b>	<b>IV</b>
<b>Title of Paper</b>	<b>Credits 2</b>
<b>I) Introduction to Basic Statistics-II</b>	<b>2 credit</b>
<b>From the Academic Year</b>	<b>2025-26</b>

<b>Open Elective-I</b>		
<b>Introduction to Basic Statistics-II</b>		
<b>Sr. No.</b>		<b>Particulars</b>
<b>1</b>	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<p>Introduction:</p> <p>Introduction to Basic Statistics-II course is focuses on to equip students with basic theory of probability and standard discrete distributions. Student will learn basic elementary probability theory, discrete random variables and continuous random variables. Also students will be acquiring knowledge about correlation and predictive analysis.</p> <p>This course will be useful for science, humanity and commerce faculty. This course will be offered other than science faculty students which will be very useful to gain knowledge about basic statistics in their field. This course will be applicable to various field to analyze their basic data structure.</p> <p>This course is focuses practical as well as theoretical aspects of basic statistics along with subjects from psychology, Economics, sociology, commerce, Computers , Mathematics , IT etc.</p> <p>There is growing demand for highly skilled statisticians in the 21st century in many fields including government, banking sector, health sciences, veterinary sciences, agricultural sciences, business, and social sciences etc</p>
<b>2</b>	<b>Vertical :</b>	Open Elective
<b>3</b>	<b>Type :</b>	Theory
<b>4</b>	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted :</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks

7	<p><b>Course Objectives:</b> : Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand difference between random and non-random experiment.</li> <li>2. Understand the concept of probability and its applications</li> <li>3. Understand the meaning of continuous and discrete random variable.</li> <li>4. Understand discrete distributions and their properties.</li> <li>5. Solve the examples on probability and probability distributions.</li> </ol>						
8	<p><b>Course Outcomes:</b> On successful completion of this course Students Should be able to,</p> <ol style="list-style-type: none"> <li>1. Identify the types of events</li> <li>2. Calculate probabilities and conditional probabilities.</li> <li>3. Apply the concept of probability in real-life situations.</li> <li>4. Compute the expectation of the uni-variate discrete random variable.</li> <li>5. Write probability mass functions (p.m.f.) of various discrete distribution and their real-life applications.</li> <li>6. Understand the concept and difference between correlation and regression</li> </ol>						
9	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><b>Modules:-</b></th> <th style="text-align: center;"><b>Lect ures</b></th> </tr> </thead> <tbody> <tr> <td><b>Module 1: Elementary Probability Theory</b></td> <td></td> </tr> <tr> <td> <ul style="list-style-type: none"> <li>• Definitions: Trial, random and non-random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: complementary event, equally likely events, certain event, impossible event, independent events, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability.</li> <li>• Conditional probability.</li> <li>• Theorems (without proof ) and their applications:               <ol style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ol> </li> </ul> <p>Simple examples based on all concepts.</p> <ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables. Definition and properties of probability mass function .</li> </ul> </td> <td style="text-align: center; vertical-align: top;">15</td> </tr> </tbody> </table>	<b>Modules:-</b>	<b>Lect ures</b>	<b>Module 1: Elementary Probability Theory</b>		<ul style="list-style-type: none"> <li>• Definitions: Trial, random and non-random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: complementary event, equally likely events, certain event, impossible event, independent events, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability.</li> <li>• Conditional probability.</li> <li>• Theorems (without proof ) and their applications:               <ol style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ol> </li> </ul> <p>Simple examples based on all concepts.</p> <ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables. Definition and properties of probability mass function .</li> </ul>	15
<b>Modules:-</b>	<b>Lect ures</b>						
<b>Module 1: Elementary Probability Theory</b>							
<ul style="list-style-type: none"> <li>• Definitions: Trial, random and non-random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: complementary event, equally likely events, certain event, impossible event, independent events, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability.</li> <li>• Conditional probability.</li> <li>• Theorems (without proof ) and their applications:               <ol style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ol> </li> </ul> <p>Simple examples based on all concepts.</p> <ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables. Definition and properties of probability mass function .</li> </ul>	15						

<p>cumulative distribution function.</p> <ul style="list-style-type: none"> <li>• Expectation and variance of a random variable. Theorems and properties on Expectation and variance of random variables without proof.</li> <li>• Raw and Central moments (definition only) and their relationship. (up to order four).</li> <li>• Joint probability mass function of two discrete random variables. Covariance</li> </ul>	
<p><b>Module 2: Correlation and Regression Analysis.</b></p>	<p><b>15</b></p>
<ul style="list-style-type: none"> <li>• Correlation analysis: Meaning, types of correlation</li> <li>• Scatter Diagram, product moment or Karl Pearson's correlation coefficient and its properties.</li> <li>• Spearman's Rank correlation (With and without ties)</li> <li>• Concept of linear regression, Principle of least squares, fitting of regression lines by method of least squares.</li> <li>• Properties of regression equations.</li> <li>• Relation between regression coefficients and correlation coefficient.</li> <li>• Concept and use of coefficient of determination (<math>R^2</math>).</li> <li>• Introduction of discrete distributions- Discrete Uniform distribution, Binomial distribution, Poisson distribution and their characteristics (without proof) formulae) and their interpretation</li> </ul>	
<p><b>Reference Books</b></p> <ul style="list-style-type: none"> <li>• David S. : Elementary Probability, Cambridge University Press.</li> <li>• Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.</li> <li>• Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillan Publishing Co. Co. Inc.</li> <li>• Pitan Jim : Probability, Narosa Publishing House.</li> <li>• Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II :The World Press Private Limited, Calcutta.</li> <li>• Mukhopadhyay P. An Introduction to the Theory of</li> </ul>	

Probability, World Scientific Publishing Company,  
2011.

- Grewal P. S, Methods of Statistical Analysis, Sterling Publishers, 1990
- S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons

### **Format of Question Paper:**

#### **Internal Continuous Assessment: (20 marks)**

<b>Assignment/viva</b> Quizzes, Class Tests, presentation, project, assignment etc	<b>Class Test</b>	<b>Total</b>
05	15	20

#### **Semester End Examination: (30 marks)**

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

#### **Theory Question Paper Pattern:**

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

**Sd/-**

**Sign of the BOS Chairman  
Dr. Santosh Gite  
Board of Studies in  
Statistics**

**Sd/-**

**Sign of the  
Offg. Associate Dean  
Dr. Madhav R. Rajwade  
Faculty of Science &  
Technology**

**Sd/-**

**Sign of the  
Offg. Dean  
Prof. Shivram S. Garje  
Faculty of Science &  
Technology**

## As Per NEP 2020

# University of Mumbai



<b>Syllabus for Basket of OE Vertical 3</b>	
<b>Faculty of Science</b>	
<b>Board of Studies in Statistics</b>	
<b>UG Second Year Programme</b>	
<b>Semester</b>	<b>III</b>
<b>Title of Paper</b>	<b>Credits 2</b>
<b>I) Introduction to Basic Statistics-I</b>	<b>2 credit</b>
<b>From the Academic Year</b>	<b>2025-26</b>

**Semester-III**

**Open Electives-I**

**Name of the course: Introduction to Basic Statistics-I**

<b>Sr. No</b> .	<b>Heading</b>	<b>Particulars</b>
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1	<p><b>Description the course :</b></p> <p><b>Including but Not limited to :</b></p>	<p><b>Introduction:</b></p> <p>Introduction to Basic statistics-I course is focuses on basic statistics such as collection of data and how to measure variables on different scale. Student will equip with to identify the scale of measurement and analyze elementary statistical analysis through graphical presentation. Also student will learn to identify nature of the data through statistical methods. This course mainly emphasizes the method of collecting data, summarizing and presenting data, and drawing inferences from the data.</p> <p>This course will be useful for science, humanity and commerce faculty. This course will be offered other than science faculty students which will be very useful to gain knowledge about basic statistics in their field. This course will be applicable to various field to analyze their basic data structure.</p> <p>This course is focuses practical as well as theoretical aspects of basic statistics along with subjects from psychology, Economics, sociology, commerce, Computers , Mathematics , IT etc.</p> <p>There is growing demand for highly skilled statisticians in the 21st century in many fields including government, banking sector, health sciences, veterinary sciences, agricultural sciences, business, and social sciences etc</p>
2	<b>Vertical :</b>	Open Elective
3	<b>Type :</b>	Theory
4	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted :</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks

<b>7</b>	<p><b>Course Objectives:</b></p> <p>Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand the meaning of Statistics and scope of Statistics.</li> <li>2. Understand techniques of data collection and its presentation.</li> <li>3. Compute various measures of central tendencies to know the entire data by a centralized single value.</li> <li>4. Understand spread and variation of data using various techniques of measure of dispersion.</li> <li>5. Understand the behavior of data using skewness and kurtosis and study the nature of probability curve.</li> </ol>
<b>8</b>	<p><b>Course Outcomes:</b></p> <p><b>: on successful completion of the course Students Should be able to,</b></p> <ol style="list-style-type: none"> <li>1. Calculate arithmetic mean and its applicability</li> <li>2. Differentiate between qualitative and quantitative data through scale of measurement.</li> <li>3. Construct graphs and diagrams from data and interpret the result.</li> <li>4. Compute Skewness and Kurtosis of the data to describe nature of data distribution.</li> </ol>

<b>9</b>	<b>Modules:-</b>	<b>Lect ures</b>
	<b>Module 1: Classification, Tabulation and Presentation of data.</b>	
	<ul style="list-style-type: none"> <li>• Definition and scope of Statistics</li> <li>• Types of data: Qualitative and Quantitative data, Geographical data, Time series data and Crosssection data</li> <li>• Measurement of scales: Nominal, Ordinal, Interval and Ratio.</li> <li>• Primary data and Secondary data</li> <li>• Classification and Tabulation (One way and Two way).</li> <li>• Frequency distributions: Uni-variate and Bi-variate</li> <li>• Diagrammatic representation of data Simple bar diagram, Multiple bar diagram, Subdivided bar diagram and Pie-chart</li> <li>• Graphical representation of data Histogram, Frequency Polygon, Frequency Curve, Cumulative frequency curve (Less than and more than type).</li> </ul>	15

<p><b>Module 2: Measures of central tendency and Measures of Dispersion</b></p> <p><b>Measures of central tendency</b></p> <ul style="list-style-type: none"> <li>• Concept and Requirements of good measures of central tendency.</li> <li>• Arithmetic mean (Simple, weighted mean, combined mean)for grouped and un-grouped data, Merits, demerits and its applicability</li> <li>• Positional averages: Median, Mode, and Quartiles (for grouped and un-grouped data) Merits, demerits and its applicability</li> <li>• Graphical representation of mode, median and Quartiles.</li> <li>• Empirical relation between mean, median and mode (Only statement)</li> </ul> <p><b>Measures of Dispersion</b></p> <ul style="list-style-type: none"> <li>• Concept and requirements of good measures of dispersion.</li> <li>• Absolute and Relative measures of dispersion: Range, Quartile Deviation , Mean absolute deviation, Variance and Standard deviation (for grouped and un-grouped data) Merits, demerits and its applicability</li> <li>• Raw moments and central moments , relation between them upto order four (only statement).</li> <li>• Measures of Skewness and Kurtosis: Karl Pearson's measure of Skewness ,</li> </ul> <ul style="list-style-type: none"> <li>• Measures of skewness and kurtosis based on moments.(Only formulae) and their interpretation</li> </ul>	<p><b>15</b></p>
<p><b>Reference Books</b></p> <ul style="list-style-type: none"> <li>• David S. : Elementary Probability, Cambridge University Press.</li> <li>• Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.</li> <li>• Hogg R.V. and Tannis E.P. : Probability and Statistical Inference.McMillan Publishing Co. Inc.</li> <li>• Pitan Jim : Probability, Narosa Publishing House.</li> <li>• Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II :The World Press Private Limited, Calcutta.</li> <li>• Mukhopadhyay P. An Introduction to the Theory of</li> </ul>	

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- Grewal P. S, Methods of Statistical Analysis,  
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- S.C. Gupta and V.K. Kapoor, Fundamentals of  
Mathematical Statistics, Sultan Chand and Sons

**Format of Question Paper:**  
**Internal Continuous Assessment: (20 marks)**

<b>Assignment/viva</b> Quizzes, Class Tests, presentation, project, assignment etc	<b>Class Test</b>	<b>Total</b>
05	15	20

**Semester End Examination: (30 marks)**

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

**Theory Question Paper Pattern:**

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

**Sd/-**

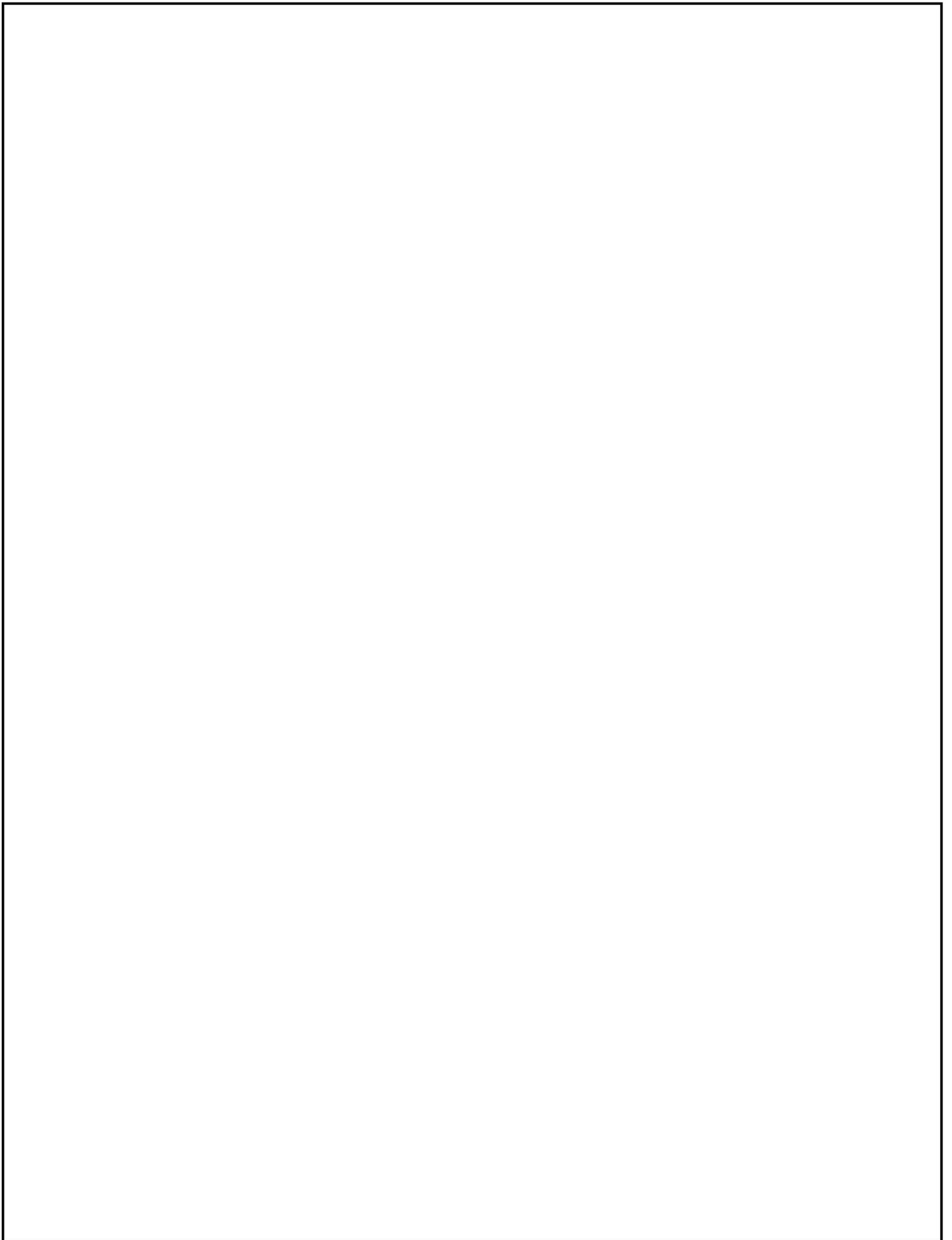
**Sign of the BOS Chairman**  
**Dr. Santosh Gite**  
**Board of Studies in**  
**Statistics**

**Sd/-**

**Sign of the**  
**Offg. Associate Dean**  
**Dr. Madhav R. Rajwade**  
**Faculty of Science &**  
**Technology**

**Sd/-**

**Sign of the**  
**Offg. Dean**  
**Prof. Shivram S. Garje**  
**Faculty of Science &**  
**Technology**



AC – 28/03/2025

Item No. – 6.3 (N) (1ab) Sem. III &amp; IV

**As Per NEP 2020****University of Mumbai**

### Syllabus for Minor Vertical 2 (Scheme – I and III)

<b>Faculty of Science</b>			
<b>Board of Studies in Mathematics</b>			
<b>Second Year Programme in Minor (Mathematics)</b>			
<b>Semester</b>		<b>III &amp; IV</b>	
<b>Title of Paper</b>		<b>Sem. III</b>	<b>Total Credits 4</b>
<b>Choose any one of the following:</b>			
1	a) Calculus- III	III	2
	b) PM-3A Calculus III	III	2
<b>OR</b>			
2	a) Vector Spaces	III	2
	b) PM-3B Vector Spaces	III	2
<b>OR</b>			
3	a) Basic Mathematics in Real Life II	III	2
	b) PM-3C Basic Mathematics in Real Life II	III	2
<b>Title of Paper</b>		<b>Sem. IV</b>	<b>Total Credits 4</b>
<b>Choose any one of the following:</b>			
1	a) Calculus IV	IV	2
	b) PM-4A Calculus IV	IV	2
<b>OR</b>			
2	a) Linear Algebra	IV	2
	b) PM-4B Linear Algebra	IV	2
<b>OR</b>			
3	a) Basic Mathematics in Real Life III	IV	2
	b) PM-4C Basic Mathematics in Real Life III	IV	2
<b>From the Academic Year</b>			<b>2025-26</b>

**Sem. - III**

**Syllabus**  
**B.Sc. (Mathematics)**  
**(Sem.- III)**

**Name of the Course: Calculus III (Minor I)**

Sr. No	Heading	Particulars
<b>1</b>	<b>Description the course: Including but not limited to:</b>	Calculus finds extensive applications in diverse fields such as Physics, Chemistry, Biotechnology, Engineering, among others. This course aims to instill a deep understanding of Mathematical Analysis as it forms a rigorous foundation for Calculus. Learners will explore properties of Real Numbers, delve into concepts like Series and Riemann integration of functions. To provide practical context, the course incorporates applications of integration, offering students a broader perspective on the diverse uses of acquired knowledge.
<b>2</b>	<b>Vertical:</b>	Minor
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<b>Course Objectives (CO):</b>	<p>This course provides an introduction to advanced concepts in analysis with a strong emphasis on rigor. It aims to prepare students for more advanced courses in abstract analysis. The focus of the course is on developing formal proof skills, which not only deepens comprehension of the subject but also extends to broader applications in mathematics.</p> <p><b>CO1:</b> Provide a solid understanding of fundamental principles and methods, equipping students with the skills to apply mathematical ideas and tools through modeling, solving, and interpretation.</p> <p><b>CO2:</b> Illustrate the expansive nature of the subject by fostering the acquisition of essential mathematical tools for continued studies across various scientific fields.</p> <p><b>CO3:</b> Foster students' comprehensive development by placing emphasis on problem-solving skills, nurturing creative talents, and enhancing communication abilities, all of which are vital for a range of employment opportunities.</p> <p><b>CO4:</b> Ensure exposure to both global and local issues within the realm of Mathematical Sciences, allowing learners to explore diverse aspects of the discipline.</p>
<b>8</b>	<b>Course Outcomes (OC):</b>	

	<p>After completion of the course, students will be able to</p> <p><b>OC1</b> Understand and remember the concepts such as convergence/ divergence of series, Riemann Integration, beta-gamma functions and related results.</p> <p><b>OC2:</b> Apply the formulae and concepts to solve the examples related to series, Riemann Integral, area between two curves etc.</p> <p><b>OC3:</b> Analyse the convergence and divergence of series and integrability of given function.</p> <p><b>OC4:</b> Justify/ check the integrability of function, absolute and conditional convergence of series.</p> <p><b>OC5:</b> Construct counter examples related to absolutely convergent/ divergent series, non-integrable functions etc.</p>
<b>9</b>	<p><b>Modules: -</b></p> <p><b>Module 1: Infinite Series (15 Lectures)</b></p> <p>1. Infinite series in <math>\mathbb{R}</math>. Definition of convergence and divergence. Basic examples including geometric series. Elementary results such as if <math>\sum_{n=1}^{\infty} a_n</math> is convergent then <math>a_n \rightarrow 0</math> but converse is not true. Cauchy Criterion, Algebra of convergent series and related examples.</p> <p>2. Tests for convergence: Comparison Test, Limit Comparison Test (without proof), Ratio Test (without proof), Root Test (without proof), Examples, p- series test.</p> <p>3. Alternating series. Leibnitz's Test. Examples. Absolute convergence, absolute convergence implies convergence but not conversely. Conditional Convergence.</p> <p><b>Module 2: Riemann Integration and Applications (15 Lectures)</b></p> <p>1. Idea of approximating the area under a curve by inscribed and circumscribed rectangles. Partitions of an interval. Refinement of a partition. Upper and Lower Riemann sums for a bounded real valued function defined on a closed and bounded interval in <math>\mathbb{R}</math>. Definition of Riemann integral.</p> <p>2. Criterion for Riemann integrability, Characterization of the Riemann integral as the limit of a sum. (without proof). Examples.</p> <p>3. Algebra of Riemann integrable functions and basic results such as if (i) <math>f:[a,b] \rightarrow \mathbb{R}</math> is integrable, then <math>\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx</math> (without proof) (ii) <math> f </math> is integrable and <math>\left  \int_a^b f(x)dx \right  \leq \int_a^b  f (x)dx</math> (iii) If <math>f(x) \geq 0</math> for all <math>x \in [a,b]</math> then <math>\int_a^b f(x)dx \geq 0</math></p> <p>4. Riemann integrability of a continuous function. Integrability of a bounded function whose set of discontinuities has only finitely many points (without proof). Riemann integrability of monotone functions.</p> <p>5. First and Second Fundamental Theorems of Calculus.</p> <p>6. Area between the two curves. Lengths of plane curves. Surface area of surfaces of revolution.</p> <p>7. Gamma and Beta functions and their properties. Relationship between them (without proof).</p>
<b>10</b>	<p><b>Recommended Reference Books:</b></p> <p>1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.</p> <p>2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.</p> <p>3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.</p> <p>4. T. Apostol; Calculus Vol. 2; John Wiley.</p>
<b>11</b>	<p><b>Additional Reference Books</b></p> <p>1. Ajit Kumar, S.Kumaresan; A Basic Course in Real Analysis; CRC Press, 2014</p>

2. D. Somasundaram and B. Choudhary; A First Course in Mathematical Analysis, Narosa, New Delhi, 1996.  
 3. K. Stewart; Calculus, Booke/Cole Publishing Co, 1994.  
 4. J. E. Marsden, A.J. Tromba and A. Weinstein; Basic Multivariable Calculus; Springer.  
 5. R.G. Bartle and D. R. Sherbert; Introduction to Real Analysis Second Ed.; John Wiley, New Yorm, 1992.  
 6. M. H. Protter; Basic Elements of Real Analysis; Springer-Verlag, New York, 1998.

**Scheme of the Examination**

The performance of the learners shall be evaluated in two parts.

- Internal Continuous Assessment of 20 marks.
- Semester End Examination of 30 marks.
- A separate head of passing is required for internal and semester-end examinations.

**12 Internal Continuous Assessment: 40% Semester End Examination: 60%**

**13 Continuous Evaluation through:** Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments etc. (at least 3)

Sr. No.	Particulars	Marks
1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10
2	Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.	05
3	Seminar/ group presentation on any one topic related to the syllabus.	05

**Paper pattern of the Test (Offline Mode with One hour duration):**

Q1: Definitions/Fill in the blanks/ True or False with Justification. (04 Marks: 4 x 1).

Q2: Attempt any 2 from 3 descriptive questions. (06 marks: 2 x 3)

**14 Format of Question Paper:**  
 The semester-end examination will be of 30 marks marks of one hour duration covering the entiresyllabus of the semester.

**Note: Attempt any TWO questions out of THREE.**

Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks

## Name of the Course: PM-3A Calculus III (Minor I)

Sr. No.	Heading	Particulars												
<b>1</b>	<b>Description the course: Including but not limited to:</b>	Problem-solving is a fundamental aspect of any Mathematics course. While advanced courses often emphasize the theoretical nature of the subject, engaging in problem-solving reinforces concepts and enhances learners' ability to analyze existing problems and devise solutions. This activity not only motivates learners but also empowers them to formulate new results, propose conjectures, and develop innovative theories.												
<b>2</b>	<b>Vertical:</b>	Minor												
<b>3</b>	<b>Type:</b>	Practical												
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)												
<b>5</b>	<b>Hours Allotted:</b>	30 Hours												
<b>6</b>	<b>Marks Allotted:</b>	50 Marks												
<b>7</b>	<b>Course Objectives (CO):</b>	<p>This course emphasizes on problem solving and motivates to think on the basic concepts of Algebra and Analysis with rigour and prepares students to study further courses.</p> <p><b>CO1.</b> To give sufficient knowledge of fundamental principles, methods and a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving and interpreting.</p> <p><b>CO2.</b> To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p><b>CO3.</b> To enhance students' overall development, problem solving skills, creative talent, and power of communication. These are necessary for various kinds of employment.</p> <p><b>CO4.</b> To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>												
<b>8</b>	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p><b>OC1:</b> Apply the formulae and concepts to solve the examples related to series, Riemann Integral, area between two curves etc.</p> <p><b>OC2:</b> Analyze the convergence and divergence of series and integrability of given function.</p> <p><b>OC3:</b> Justify/ check the integrability of function, absolute and conditional convergence of series.</p> <p><b>OC4:</b> Construct counter examples related to absolutely convergent/ divergent series, non-integrable functions etc.</p>												
<b>9</b>	<b>Modules: - Practical for Calculus III (30 Hours)</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 5%; text-align: center;">1.</td> <td>Convergent and divergent series and algebra of convergent series.</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>Comparison and limit comparison test.</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Ratio test and root test.</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>Alternating Series and p-series test.</td> </tr> <tr> <td style="text-align: center;">5.</td> <td>Absolute and conditional convergence.</td> </tr> <tr> <td style="text-align: center;">6.</td> <td>Upper sum and lower sum.</td> </tr> </tbody> </table>	1.	Convergent and divergent series and algebra of convergent series.	2.	Comparison and limit comparison test.	3.	Ratio test and root test.	4.	Alternating Series and p-series test.	5.	Absolute and conditional convergence.	6.	Upper sum and lower sum.
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6.	Upper sum and lower sum.													

	7.	Riemann integral and its properties.													
	8.	Fundamental Theorems of Calculus.													
	9.	Area between two curves, lengths of plane curves and surface area of surfaces of revolution.													
	10.	Beta and Gamma functions.													
<b>10</b>	<b>Recommended Reference Books:</b> <ol style="list-style-type: none"> <li>1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.</li> <li>2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.</li> <li>3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.</li> <li>4. T. Apostol; Calculus Vol. 2; John Wiley.</li> </ol>														
<b>11</b>	<b>Additional Reference Books</b> <ol style="list-style-type: none"> <li>1. Ajit Kumar, S.Kumaresan; A Basic Course in Real Analysis; CRC Press, 2014</li> <li>2. D. Somasundaram and B. Choudhary; A First Course in Mathematical Analysis, Narosa, New Delhi, 1996.</li> <li>3. K. Stewart; Calculus, Booke/Cole Publishing Co, 1994.</li> <li>4. J. E. Marsden, A.J. Tromba and A. Weinstein; Basic Multivariable Calculus; Springer.</li> <li>5. R.G. Bartle and D. R. Sherbert; Introduction to Real Analysis Second Ed. ; John Wiley, New Yorm, 1992.</li> <li>6. M. H. Protter; Basic Elements of Real Analysis; Springer-Verlag, New York, 1998.</li> </ol>														
	<b><u>Scheme of the Examination</u></b>														
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>													
<b>13</b>	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments etc. (at least 3) <table border="1" style="margin-top: 10px;"> <thead> <tr> <th>Sr. No.</th> <th>Particulars</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Objective question test</td> <td>10</td> </tr> <tr> <td>2</td> <td>Overall performance</td> <td>05</td> </tr> <tr> <td>3</td> <td>Viva</td> <td>05</td> </tr> </tbody> </table> <p style="margin-top: 10px;"><b>Paper pattern of the Test (Offline Mode):</b>            Q1: (Attempt any 5 from 8) Multiple choice questions. (10 marks: <math>5 \times 2</math>)</p> <p><b>Duration: 1Hrs</b>  <b>While setting question paper</b></p>			Sr. No.	Particulars	Marks	1	Objective question test	10	2	Overall performance	05	3	Viva	05
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1	Objective question test	10													
2	Overall performance	05													
3	Viva	05													

four MCQ on module 1 and  
four MCQ on module 2 both.

**14** **Format of Question Paper:**

**Scheme of examination:**

At the end of the Semester III, Practical examinations of three hours duration and 30 marks shall be conducted based on both the modules.

Paper pattern: The question paper shall have two questions.

Q. No. 1	Five out of Eight multiple choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks (3 × 5 = 15 Marks)
Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)

**Marks for Journals:**

For both Module 1 and Module 2

1. Journal: 5 marks (2.5 marks for each module 1 & module 2)

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

## Name of the Course: Vector Spaces (Minor II)

Sr. No.	Heading	Particulars
<b>1</b>	<b>Description of the course: Including but not limited to:</b>	This course covers fundamental concepts in linear algebra, concepts in mathematics with applications across various fields including physics, engineering, computer science, and economics. Learners will learn about subspaces, spanning sets, linear independence, and basis vectors, crucial concepts that form the building blocks of vector space theory.
<b>2</b>	<b>Vertical:</b>	Minor
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<b>Course Objectives (CO):</b>	<p>This course gives an introduction to vector spaces and system of linear equations and its solutions. Also, it deals with the basics of vector spaces, covering different examples and dealing with finite-dimensional vector spaces.</p> <p>CO1. To give sufficient knowledge of fundamental principles, methods, and a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving, and interpreting.</p> <p>CO2. To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p>CO3. To enhance students' overall development, problem-solving skills, creative talent, and power of communication are necessary for various kinds of employment.</p> <p>CO4. To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>
<b>8</b>	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p>OC1: Understand, remember the concepts and properties vector spaces.</p> <p>OC2: Apply the formulas and the concepts to solve examples subspaces, sum and intersection of subspaces.</p> <p>OC3: To analyse the properties of vector spaces, row space and column space of a matrix</p> <p>OC4: Justify or check a set to be a vector space.</p> <p>OC5: Construct counterexamples related to vector spaces and subspaces.</p>
<b>9</b>	<b>Modules: - Module 1: Vector spaces and subspaces (15 Hours)</b>	<p>(a) Definition of a vector space over <math>R</math>. Examples such as:</p> <p>(i) Euclidean space <math>R^n</math>.</p> <p>(ii) The space of <math>m \times n</math> matrices over <math>R</math>.</p> <p>(iii) The space of polynomials with real coefficients.</p>

	<p>(b) Subspaces: definition, criterion for a nonempty subset to be a subspace of a vector space. Examples, including:</p> <p>(i) Lines in <math>R^2</math>, Lines and planes in <math>R^3</math>.</p> <p>(ii) The solutions of a homogeneous system of linear equations.</p> <p>(iii) The spaces of symmetric, skew-symmetric, upper triangular, lower triangular, and diagonal matrices.</p> <p>(iv) The space of polynomials with real coefficients of degree <math>\leq n</math>.</p> <p>(c) The sum, union and intersection of subspaces, direct sum of vector spaces. Cosets, Introduction to quotient space.</p>										
	<p><b>Module 2: System of linear equations, Linear combination, Basis of vector spaces (15 Hours)</b></p>										
	<p>(a) (i) Introduction to linear systems, Matrix representation of the system of homogeneous and non-homogeneous linear equations, row echelon form, Gauss Elimination.</p> <p>(ii) Linear combination of vectors.</p> <p>(iii) Linear span of a subset of a vector space.</p> <p>(iv) Linear dependence and independence of a set.</p> <p>(b) Basis of a vector space, Dimension of a vector space. The discussion of these concepts is for finitely generated vector spaces only.</p> <p>(c) (i) Row space, column space of a <math>m \times n</math> matrix over <math>R</math> and row rank, column rank of a matrix.</p> <p>(ii) Equivalence of row rank and column rank, computing the rank of a matrix by row reduction.</p>										
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd edition, Pearson.</li> <li>2. Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).</li> <li>3. Serge Lang, Introduction to Linear Algebra, Springer.</li> <li>4. S Kumaresan, Linear Algebra: A Geometric Approach, PHI Learning.</li> </ol>										
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	<p><b><u>Scheme of the Examination</u></b></p>										
	<p>The performance of the learners shall be evaluated in two parts.</p> <ul style="list-style-type: none"> <li>● Internal Continuous Assessment of 20 marks.</li> <li>● Semester examination of 30 marks.</li> <li>● A separate head of passing is required for internal and semester-end examinations.</li> </ul>										
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>									
<b>13</b>	<p><b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc. (at least 3)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sr. No.</th> <th style="width: 70%;">Particulars</th> <th style="width: 20%;">Marks</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>A class test of 10 marks is to be conducted during each semester in an Offline mode.</td> <td style="text-align: center;">10</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Project on any one topic</td> <td style="text-align: center;">05</td> </tr> </tbody> </table>		Sr. No.	Particulars	Marks	1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10	2	Project on any one topic	05
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1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10									
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		related to the syllabus or a quiz (offline/online) on one of the modules.		
	3	Seminar/group presentation on any one topic related to the syllabus.	05	
<p><b>Paper pattern of the Test (Offline Mode with One-Hour Duration):</b>  Q1: Definitions/Fill in the blanks/ True or False with Justification. (04 Marks: 4 x 1).  Q2: Attempt any 2 from 3 descriptive questions. (06 marks: 2 x 3)</p>				
<b>14</b>	<p><b>Format of Question Paper:</b>  The semester-end examination will be of 30 marks of one-hour duration, covering the entire syllabus of the semester.</p>			
<b>Note: Attempt any TWO questions out of THREE.</b>				
	Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
	Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
	Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks

## Name of the Course: PM-3B Vector Spaces (Minor II)

Sr. No.	Heading	Particulars																
1	<b>Description of the course: Including but not limited to:</b>	This course covers fundamental concepts in linear algebra, concepts in mathematics with applications across various fields including physics, engineering, computer science, and economics. Learners will learn about subspaces, spanning sets, linear independence, and basis vectors, crucial concepts that form the building blocks of vector space theory.																
2	<b>Vertical:</b>	Minor																
3	<b>Type:</b>	Practical																
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)																
5	<b>Hours Allotted:</b>	30 Hours																
6	<b>Marks Allotted:</b>	50 Marks																
7	<b>Course Objectives (CO):</b>	<p>This course gives an introduction to vector spaces and system of linear equations and its solutions. Also, it deals with the basics of vector spaces, covering different examples and dealing with finite-dimensional vector spaces.</p> <p>CO1. To give sufficient knowledge of fundamental principles, methods, and a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving, and interpreting.</p> <p>CO2. To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p>CO3. To enhance students' overall development, problem-solving skills, creative talent, and the power of communication are necessary for various kinds of employment.</p> <p>CO4. To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>																
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p>OC1: Apply the formulas and the concepts to solve examples related to vector spaces.</p> <p>OC2: To analyse and test the property of vector subspaces on sets.</p> <p>OC3: To check linear independence, and dependence of vectors.</p> <p>OC4: Construct basis and counter-examples related to vector spaces and subspaces.</p>																
9	<b>Modules: - Module 1: Vector spaces and subspaces (30 Hours)</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="text-align: center;">1.</td> <td>Vector spaces-I (Examples)</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>Vector spaces-II (To check which of the given sets are vector spaces)</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Subspaces of Euclidean space</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>Subspaces of Polynomial space</td> </tr> <tr> <td style="text-align: center;">5.</td> <td>Subspaces of Matrix space</td> </tr> <tr> <td style="text-align: center;">6.</td> <td>Sum of subspaces</td> </tr> <tr> <td style="text-align: center;">7.</td> <td>Intersection of subspaces</td> </tr> <tr> <td style="text-align: center;">8.</td> <td>Union of subspaces</td> </tr> </tbody> </table>	1.	Vector spaces-I (Examples)	2.	Vector spaces-II (To check which of the given sets are vector spaces)	3.	Subspaces of Euclidean space	4.	Subspaces of Polynomial space	5.	Subspaces of Matrix space	6.	Sum of subspaces	7.	Intersection of subspaces	8.	Union of subspaces
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**Duration: 1Hrs**  
**While setting the question paper, four MCQs on module 1 and four MCQs on module 2 both.**

**14** **Format of Question Paper:**  
**Scheme of examination:**

At the end of Semester III, Practical examinations of three hours duration and 30 marks shall be conducted based on both modules.

Paper pattern: The question paper shall have two questions.

Q. No. 1	Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks (3 × 5 = 15 Marks)
Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)

**Marks for Journals:**

For both Module 1 and Module 2,

Journal: 5 marks (2.5 marks for each module 1 & module 2)

The students are required to perform 75% of the practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**Name of the Course: Basic Mathematics in Real Life-II  
(Minor III)**

Sr. No.	Heading	Particulars
1	<b>Description of the course: Including but not limited to:</b>	To demonstrate the importance of mathematics in real life by considering interdisciplinary applications of basic concepts in real life.
2	<b>Vertical:</b>	Minor
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b>	This course is a balanced mixture of the basic concepts of mathematics, which highlights the crucial role of mathematics in other sciences. In this course, students from various science streams will be able to see mathematics being applied in their area of interest and learn CO1: To develop methods for polynomial interpolation. CO2: To identify row echelon form and row reduced echelon form for matrices. CO3: To associate mathematical notation for solving real-life problems like those related to forest management. CO4: To recognize the role of geometry (in particular Platonic solids) in science streams.
8	<b>Course Outcomes (OC):</b>	After completion of the course, students will be able to OC1: Understand and remember the polynomials, polynomial graphs, Fibonacci sequence, platonic solids and Matrices OC2: Apply the formulas and concepts to solve problems and examples related to quadratic equations recurrence relations, matrices and platonic solids OC3: Examine and investigate the growth matrices, echelon form of matrices, and Kirchhoff's Law using matrices. OC4: Justify and check the inverse of matrices and applications of the golden ratio. OC5: Design and construct circuits using Kirchhoff's Laws
9	<b>Modules: - Module 1: Polynomials and interpolation (15 Hours)</b>	1. Solving a quadratic equation: conditions for repeated roots, discriminant 2. Plotting a polynomial graph for degree two when roots are real. Example: (monic; not monic) 3. Relation between roots and coefficients of a polynomial (degree two), plotting polynomial of degree three (some specific examples). 4. Fibonacci numbers: motivation and recurrence relation. Simple examples of recurrence. 5. Sunflower and Golden ratio. 6. Polynomial interpolation: Statement of the problem and motivation; calculation in degree two. 7. Matrices (not necessarily square) and multiplication formula for two matrices under suitable conditions; examples. 8. Forest management—I: introduction to growth matrix.

	<p>9. Forest management II: Statements and notations for optimal sustainable yield.</p> <p>10. Forest management III : Computation of solution</p> <p>11. Row echelon and Row reduced echelon form: Definition and computation in 2 by 2 matrices.</p> <p>12. Row echelon and row reduced echelon form: computation in 3 by 3 matrices.</p> <p>13. Definition of the inverse of a matrix, Elementary matrices and calculation of inverse in particular examples (size 2,3)</p> <p>14. Polynomial interpolation in degree three: simple examples.</p> <p>15. Vander monde matrix and computation of its determinant (by stating properties of determinant).</p>	
	<p><b>Module 2: Applications of linear systems and introduction to platonic solids (15 Hours)</b></p>	
	<ol style="list-style-type: none"> <li>1. Kirchoff's laws recall and setting up notation.</li> <li>2. Kirchoff's laws and determination of current in a circuit (setting up a linear system of equations).</li> <li>3. Kirchoff's laws and explicit examples.</li> <li>4. Cofactor, Adjoint of a Matrix: Definitions.</li> <li>5. Computation of cofactor and adjoint of two-by-two matrices.</li> <li>6. Computation of cofactor and adjoint of three-by-three matrices.</li> <li>7. Formula stating the relation between a matrix, adjoint, and inverse.</li> <li>8. Computation of adjoint and inverse for higher-size matrices.</li> <li>9. Relation between invertibility and uniqueness of solution to a linear system of equations (only statement) and examples.</li> <li>10. Counting edges, faces, and vertices in planar and non-coplanar figures. Statement of Euler's formula.</li> <li>11. Platonic solids: introducing five platonic solids with names, verifying Euler's formula.</li> <li>12. Proof of the existence of only five platonic solids.</li> <li>13. Duals of platonic solids, the existence of molecules in the shape of platonic solids, and the impossibility of certain crystal shapes.</li> <li>14. George Mendel and his experiment and introduction to The hardy-Weinberg principle in population genetics</li> <li>15. Punnett square and associated binomial expansions.</li> </ol>	
<b>10</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Hermann Weyl, Symmetry, Princeton University Press, 1952.</li> <li>2. Elementary Linear Algebra Application Version, H. Anton, C. Rorres, Wiley, Tenth Edition.</li> </ol>	
<b>11</b>	<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Contemporary Abstract Algebra, J. A. Gallian, Narosa publishing house.</li> <li>2. Tipler, Paul (2004). Physics for Scientists and Engineers: Electricity, Magnetism, Light, and Elementary Modern Physics (5th ed.). W. H. Freeman.</li> </ol>	
	<p><b><u>Scheme of the Examination</u></b></p>	
	<p>The performance of the learners shall be evaluated in two parts.</p> <ul style="list-style-type: none"> <li>● Internal Continuous Assessment of 20 marks.</li> <li>● Semester-end examination of 30 marks.</li> <li>● A separate head of passing is required for internal and semester-end examinations.</li> </ul>	
<b>12</b>	<p><b>Internal Continuous Assessment: 40%</b></p>	<p><b>Semester End Examination: 60%</b></p>

**13** **Continuous Evaluation through:** Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc.  
(at least 3)

Sr. No.	Particulars	Marks
1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10
2	Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.	05
3	Seminar/group presentation on any one topic related to the syllabus.	05

**Paper pattern of the Test (Offline Mode with One Hour Duration):**

Q1: Definitions/Fill in the blanks/ True or False with Justification.

(04 Marks: 4 x 1).

Q2: Attempt any 2 from 3 descriptive questions. (06 marks: 2 x 3)

**14** **Format of Question Paper:**

The semester-end examination will be of 30 marks of one hour duration, covering the entire syllabus of the semester.

**Note: Attempt any TWO questions out of THREE.**

Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks

**Name of the Course: PM-3C Basic Mathematics in Real Life-II  
(Minor III)**

Sr. No.	Heading	Particulars																				
1	<b>Description of the course: Including but not limited to:</b>	To demonstrate the importance of mathematics in real life by considering interdisciplinary applications of basic concepts in real life.																				
2	<b>Vertical:</b>	Minor																				
3	<b>Type:</b>	Practical																				
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)																				
5	<b>Hours Allotted:</b>	30 Hours																				
6	<b>Marks Allotted:</b>	50 Marks																				
7	<b>Course Objectives (CO):</b>	<p>This course is a balanced mixture of the basic concepts of mathematics, which highlights the crucial role of mathematics in other sciences. In this course, students from various science streams will be able to see mathematics being applied in their area of interest and learn</p> <p>CO1: To develop methods for polynomial interpolation.            CO2: To identify row echelon form and row reduced echelon form for matrices.            CO3: To associate mathematical notation for solving real-life problems like those related to forest management.            CO4: To recognise the role of geometry (in particular Platonic solids) in science streams.</p>																				
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p>OC1: Apply the formulas and concepts to solve interpolation problems, problems, and examples related to polynomials up to degree three, equations of recurrence relations.            OC2: analyse the solutions of the system of linear equations and graphs            OC3: Check the relation between non-planar graphs and Euler's formula and verify the Hardy-Weinberg principle.            OC4: Construct the recurrence relations and design circuits based on Kirchhoff's Law</p>																				
9	<b>Modules: - Module 1: Practicals for Polynomials and Interpolation (30 Hours)</b>	<table border="1"> <tbody> <tr> <td>1.</td> <td>Computing roots for quadratic equations.</td> </tr> <tr> <td>2.</td> <td>Plotting polynomials of degree at most three.</td> </tr> <tr> <td>3.</td> <td>Setting up Recurrence Relations.</td> </tr> <tr> <td>4.</td> <td>Polynomial Interpolation with Examples.</td> </tr> <tr> <td>5.</td> <td>Multiplication of matrices of arbitrary sizes.</td> </tr> <tr> <td>6.</td> <td>Computation of Row-Echelon Form in 2 by 2 and 3 by 3 matrices.</td> </tr> <tr> <td>7.</td> <td>Computation of Row-Reduced-Echelon Form in 2 by 2 and 3 by 3 matrices.</td> </tr> <tr> <td>8.</td> <td>Calculating inverses of 2 by 2 matrices and 3 by 3 matrices.</td> </tr> <tr> <td>9.</td> <td>Polynomial Interpolation in Degree Three.</td> </tr> <tr> <td>10.</td> <td>Vandermonde Determinant and Invertibility.</td> </tr> </tbody> </table>	1.	Computing roots for quadratic equations.	2.	Plotting polynomials of degree at most three.	3.	Setting up Recurrence Relations.	4.	Polynomial Interpolation with Examples.	5.	Multiplication of matrices of arbitrary sizes.	6.	Computation of Row-Echelon Form in 2 by 2 and 3 by 3 matrices.	7.	Computation of Row-Reduced-Echelon Form in 2 by 2 and 3 by 3 matrices.	8.	Calculating inverses of 2 by 2 matrices and 3 by 3 matrices.	9.	Polynomial Interpolation in Degree Three.	10.	Vandermonde Determinant and Invertibility.
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**Module 2: Practicals for Applications of linear systems and introduction to Platonic solids (30 Hours)**

1.	Kirchhoff's Law in Computing Current in given examples.
2.	Computing cofactors of 2 by 2 and 3 by 3 matrices.
3.	Computing adjoint and inverse of 2 by 2 matrices.
4.	Computing the adjoint and inverse of 3 by 3 matrices.
5.	Determining solutions to linear systems of equations using matrices.
6.	Examples in n by n matrices to System of Linear Equations.
7.	Euler's Formula via Examples.
8.	Planar Figures and Graphs, Definition and Examples.
9.	Non-Planar Figures and Relation to Euler's Formula.
10.	Problems based on the Hardy-Weinberg principle.

- 10 Text Books:**
1. Artin, Algebra, Pearson, Second Edition.
  2. Elementary Linear Algebra Application Version, H. Anton, C. Rorres, Wiley, Tenth Edition.

- 11 Reference Books:**
1. Contemporary Abstract Algebra, J. A. Gallian, Narosa publishing house.
  2. Tipler, Paul (2004). Physics for Scientists and Engineers: Electricity, Magnetism, Light, and Elementary Modern Physics (5th ed.). W. H. Freeman.

**Scheme of the Examination**

**12 Internal Continuous Assessment: 40% Semester End Examination: 60%**

**13 Continuous Evaluation through:**  
Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc.  
(at least 3)

Sr. No.	Particulars	Marks
1	Objective question test	10
2	Overall performance	05
3	Viva	05

**Paper pattern of the Test (Offline Mode):**

Q1: (Attempt any 5 from 8) Multiple-choice questions. (10 marks:  $5 \times 2$ )

**Duration: 1Hrs**

**While setting the question paper, four MCQs on module 1 and four MCQs on module 2**

	<b>both.</b>							
<b>14</b>	<p><b>Format of Question Paper:</b>  <b>Scheme of examination:</b></p> <p>At the end of the Semester III, Practical examinations of three hours duration and 30 marks shall be conducted based on both the modules.  Paper pattern: The question paper shall have two questions.</p> <table border="1"> <tr> <td>Q. No. 1</td> <td>Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)</td> <td>Marks (3 × 5 = 15 Marks)</td> </tr> <tr> <td>Q. No.2</td> <td>Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)</td> <td>(5 × 2 = 10 Marks)</td> </tr> </table> <p><b>Marks for Journals:</b></p> <p>For both Module 1 and Module 2,  Journal: 5 marks (2.5 marks for each module 1 &amp; module 2)</p> <p>The students are required to perform 75% of the practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.</p>		Q. No. 1	Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks (3 × 5 = 15 Marks)	Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)
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Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)						

**Sem. – IV**

## Name of the Course: Calculus IV (Minor I)

Sr. No.	Heading	Particulars
1	<b>Description the course: Including but not limited to:</b>	Calculus finds extensive applications in diverse fields such as Physics, Chemistry, Biotechnology, Engineering, and more. This course seeks to provide learners with a comprehensive understanding of Multivariable Calculus, building upon a rigorous foundation laid by Mathematical Analysis. Through the exploration of various properties of derivatives of scalar fields and vector fields. Students will gain valuable insights into the analytical aspects of Multivariable Calculus. To enhance practical understanding, the course incorporates real-world applications of differentiation in multiple dimensions, allowing learners to grasp the diverse uses of the acquired knowledge.
2	<b>Vertical:</b>	Minor
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b>	<p>This course aims to equip students with a comprehensive understanding of functions of several variables and the principles of differentiation for scalar and vector fields in multivariable calculus.</p> <p><b>CO1:</b> To develop the understanding of vectors in <math>\mathbb{R}^n</math> focusing on <math>\mathbb{R}^2</math> and <math>\mathbb{R}^3</math> and acquire proficiency in working with real-valued functions of several variables.</p> <p><b>CO2:</b> To demonstrate competence in analyzing neighbourhoods in <math>\mathbb{R}^n</math> and applying concepts of limits and continuity to scalar fields.</p> <p><b>CO3:</b> To define and compute partial and directional derivatives of scalar fields, focusing on <math>\mathbb{R}^2</math> and <math>\mathbb{R}^3</math>, and understand the Mean Value Theorem for scalar fields.</p> <p><b>CO4:</b> To explore the basic properties of differentiability, such as continuity at a point, existence of partial derivatives, and differentiability when partial derivatives exist and are continuous.</p> <p><b>CO5:</b> To utilize concept of differentiation for practical applications, including the understanding of tangent planes and maxima-minima.</p> <p><b>CO6:</b> To understand higher-order partial derivatives and their applications, including the Mixed Partial Derivatives Theorem, Taylor's Theorem for twice continuously differentiable functions, the Method of Lagrange Multipliers and the Second Derivative Test for functions of two variables.</p>
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able</p> <p><b>OC1:</b> understand and remember the concepts such as Euclidean spaces, norm, inner product, limit, continuity, derivatives of scalar fields etc.</p> <p><b>OC2:</b> apply first and second derivative tests to find extreme values of scalar fields.</p> <p><b>OC3:</b> verify the relationship between Differentiability and Continuity, directional derivative and continuity etc.</p>

	<p><b>OC4:</b> check differentiability and continuity of scalar and vector fields.</p> <p><b>OC5:</b> create counter examples related to continuity and differentiability, directional derivative and continuity, partial derivatives and total derivative etc.</p>
<b>9</b>	<p><b>Modules: -</b></p> <p><b>Module 1: Functions of Several Variables (15 Lectures)</b></p> <ol style="list-style-type: none"> <li>1 Review of vectors in <math>\mathbb{R}^n</math> [with emphasis on <math>\mathbb{R}^2</math> and <math>\mathbb{R}^3</math>] and basic notions such as addition and scalar multiplication, inner product, length (norm) and distance between two points.</li> <li>2 Real-valued functions of several variables (Scalar fields). Graph of a function. Level sets (level curves, level surfaces, etc). Examples. Vector valued functions of several variables (Vector fields). Component functions. Examples.</li> <li>3 Sequence in <math>\mathbb{R}^n</math> [with emphasis on <math>\mathbb{R}^2</math> and <math>\mathbb{R}^3</math>] and their limits. Neighbourhoods in <math>\mathbb{R}^n</math>. Limits and continuity of scalar fields. Sequential characterizations (without proof), Composition of continuous functions. Algebra of limits and continuity (Results with proofs). Iterated and simultaneous limits of scalar fields. Limits and continuity of vector fields. Algebra of limits and continuity of vector fields. (without proofs).</li> <li>4 Partial derivatives, directional derivatives and gradient of scalar fields (with emphasis on <math>\mathbb{R}^2</math> and <math>\mathbb{R}^3</math>). Existence of directional derivative implies continuity. Mean Value Theorem for scalar fields.</li> <li>5 Differentiability of scalar fields (in terms of linear transformation). Concept of total derivative and its uniqueness, basic results such as (i) continuity at a point of differentiability, (ii) existence of partial derivatives at a point of differentiability and (iii) differentiability when the partial derivatives exist and are continuous.</li> </ol> <p><b>Module 2: Applications of Differentiability (15 Lectures)</b></p> <ol style="list-style-type: none"> <li>1 Relation between total derivative and gradient of a function. Chain rule (without proof). Geometric properties of gradient. Tangent planes.</li> <li>2 Euler's Theorem, Higher order partial derivatives. Mixed Partial Derivatives Theorem (n=2).</li> <li>3 Taylor's Theorem for twice continuously differentiable functions (without proof).</li> <li>4 The maximum and minimum rate of change of scalar fields. Notions of local maxima, local minima and saddle points. First Derivative Test. Examples. Hessian matrix. Second Derivative Test for functions of two variables (statement only). Examples. Method of Lagrange Multipliers.</li> </ol>
<b>10</b>	<p><b>Recommended Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. T. Apostol; Calculus, Vol. 2 (Second Edition); John Wiley.</li> <li>2. Sudhir Ghorpade, Balmohan Limaye; A Course in Multivariable Calculus and Analysis (Second Edition); Springer.</li> <li>3. Walter Rudin; Principles of Mathematical Analysis; McGraw-Hill, Inc.</li> <li>4. J. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus; Springer.</li> <li>5. D. Somasundaram and B. Choudhary; A First Course in Mathematical Analysis, Narosa New Delhi, 1996.</li> <li>6. K. Stewart; Calculus; Booke/Cole Publishing Co, 1994.</li> </ol>
<b>11</b>	<p><b>Additional Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Calculus and Analytic Geometry, G.B. Thomas and R. L. Finney, (Ninth Edition); Addison-</li> </ol>

	<p>Wesley, 1998.</p> <p>2. Howard Anton; Calculus- A new Horizon, (Sixth Edition); John Wiley and Sons Inc, 1999.</p> <p>3. Shabanov, Sergei; Concepts in Calculus, III: Multivariable Calculus; University Press of Florida, 2012.</p> <p>4. S C Malik and Savita Arora; Mathematical Analysis; New Age International Publishers.</p>														
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	<p>The performance of the learners shall be evaluated in two parts.</p> <ul style="list-style-type: none"> <li>• Internal Continuous Assessment of 20 marks.</li> <li>• Semester End Examination of 30 marks.</li> <li>• A separate head of passing is required for internal and semester-end examinations.</li> </ul>														
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>													
<b>13</b>	<p><b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments etc. (at least 3)</p> <table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Particulars</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>A class test of 10 marks is to be conducted during each semester in an Offline mode.</td> <td>10</td> </tr> <tr> <td>2</td> <td>Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.</td> <td>05</td> </tr> <tr> <td>3</td> <td>Seminar/ group presentation on any one topic related to the syllabus.</td> <td>05</td> </tr> </tbody> </table> <p><b>Paper pattern of the Test (Offline Mode with One hour duration):</b>  Q1: Definitions/Fill in the blanks/ True or False with Justification.  (04 Marks: 4 x 1).  Q2: Attempt any 2 from 3 descriptive questions. (06 marks: 2 x 3)</p>			Sr. No.	Particulars	Marks	1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10	2	Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.	05	3	Seminar/ group presentation on any one topic related to the syllabus.	05
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<b>14</b>	<p><b>Format of Question Paper:</b></p> <p>The semester-end examination will be of 30 marks of one hour duration covering the entire syllabus of the semester.</p> <table border="1" style="width: 100%;"> <tr> <td colspan="4" style="text-align: center;"><b>Note: Attempt any TWO questions out of THREE.</b></td> </tr> <tr> <td style="width: 15%;">Q.No.1</td> <td style="width: 15%;">Module 1 and 2</td> <td style="width: 55%;">Attempt any <b>THREE</b> out of <b>FOUR</b>. (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5</td> <td style="width: 15%;">15 Marks</td> </tr> </table>			<b>Note: Attempt any TWO questions out of THREE.</b>				Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks				
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Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks

## Name of the Course: PM-4A Calculus IV (Minor I)

Sr. No.	Heading	Particulars								
1	<b>Description the course: Including but not limited to:</b>	Problem solving forms one of the basic aspects of any course in Mathematics. Higher courses in Mathematics focus mainly on the theoretical nature of the subject, nevertheless, the problem- solving activity strengthens the concepts and helps the learners develop their ability to think over the existing problems in the subject, and also to create and crack new problems! This way a learner is not just motivated, but elevated also, to formulate new results, suggest new postulates (usually known as conjectures), and design new theories.								
2	<b>Vertical:</b>	Minor								
3	<b>Type:</b>	Practical								
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)								
5	<b>Hours Allotted:</b>	30 Hours								
6	<b>Marks Allotted:</b>	50 Marks								
7	<b>Course Objectives (CO):</b>	<p>This course introduces basic concepts of Calculus, Linear Algebra and differential equation with rigour and prepares students to study further courses.</p> <p><b>CO1.</b> To give sufficient knowledge of fundamental principles, methods, and a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving and interpreting.</p> <p><b>CO2.</b> To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p><b>CO3.</b> To enhance students' overall development, problem solving skills, creative talent, and power of communication, which are necessary for various kinds of employment.</p> <p><b>CO4.</b> To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>								
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able</p> <p><b>OC1:</b> apply first and second derivative tests to find extreme values of scalar fields.</p> <p><b>OC2:</b> verify the relationship between Differentiability and Continuity, directional derivative and continuity etc.</p> <p><b>OC3:</b> check differentiability and continuity of scalar and vector fields.</p> <p><b>OC4:</b> create counter examples related to continuity and differentiability, directional derivative and continuity, partial derivatives and total derivative etc.</p>								
9	<b>Modules: - Practical for Calculus IV (30 Hours)</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: center;">1.</td> <td>Limits and continuity of scalar fields, using "definition and otherwise", iterated limits.</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>Directional derivatives, partial derivatives and mean value theorem of scalar fields.</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Differentiability of scalar field and Total derivative.</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>Gradient, level sets and tangent planes.</td> </tr> </table>	1.	Limits and continuity of scalar fields, using "definition and otherwise", iterated limits.	2.	Directional derivatives, partial derivatives and mean value theorem of scalar fields.	3.	Differentiability of scalar field and Total derivative.	4.	Gradient, level sets and tangent planes.
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	5.	Chain rule, higher order partial derivatives and mixed partial derivatives of scalar fields.												
	6.	Maximum and minimum rate of change of scalar fields. Finding Hessian/Jacobian matrix.												
	7.	Taylor's Theorem.												
	8.	Finding maxima, minima and saddle points. Second derivative test for extrema of functions of two variables and method of Lagrange multipliers.												
	9.	Wronskian and linear independence of solutions.												
	10.	Higher order homogeneous linear differential equations with constant coefficients.												
<b>10</b>	<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. Apostol; Calculus, Vol. 2 (Second Edition); John Wiley.</li> <li>2. Sudhir Ghorpade, Balmohan Limaye; A Course in Multivariable Calculus and Analysis (Second Edition); Springer.</li> <li>3. Walter Rudin; Principles of Mathematical Analysis; McGraw-Hill, Inc.</li> <li>4. J. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus; Springer.</li> <li>5. D. Somasundaram and B.Choudhary; A First Course in Mathematical Analysis, Narosa New Delhi, 1996.</li> <li>6. K. Stewart; Calculus; Booke/Cole Publishing Co, 1994.</li> </ol>												
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1	Objective question test	10												
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	<p><b>Paper pattern of the Test (Offline Mode):</b>  Q1: (Attempt any 5 from 8) Multiple choice questions. (10 marks: 5 × 2)</p> <p><b>Duration: 1Hrs</b>  <b>While setting question paper four MCQ on module 1 and four MCQ on module 2 both.</b></p>	
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**14**

**Format of Question Paper:**

**Scheme of examination:**

At the end of the Semester IV, Practical examinations of three hours duration and 30 marks shall be conducted based on both the modules.

Paper pattern: The question paper shall have two questions.

Q. No. 1	Five out of Eight multiple choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks (3 × 5 = 15 Marks)
Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)

**Marks for Journals:**

For both Module 1 and Module 2

1. Journal: 5 marks (2.5 marks for each module 1 & module 2)

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

## Name of the Course: Linear Algebra (Minor II)

Sr. No.	Heading	Particulars
1	<b>Description of the course: Including but not limited to:</b>	The system of linear equations arises naturally in other science courses. This course provides a sound knowledge of Matrix theory, starting with the basic requirement of its study in the form of solving a system of equations. Also, it advances the discussion of vector space dealing with linear transformations, developing its connection with matrix theory.
2	<b>Vertical:</b>	Minor
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b>	<p>This course gives an introduction to linear transformations with an understanding of its geometry. Also, it covers a brief amount of matrix theory.</p> <p>CO1. To give sufficient knowledge of fundamental principles and methods, as well as a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving, and interpreting.</p> <p>CO2. To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p>CO3. To enhance students' overall development, problem-solving skills, creative talent and power of communication are necessary for various kinds of employment.</p> <p>CO4. To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p>OC1: Remember and understand the concept of a system of linear equations, matrices and linear transformations</p> <p>OC2: Calculate and find the solutions to a system of equations using various methods, finding the inverse of matrices</p> <p>OC3: Analyse the linear transformation and its various aspects</p> <p>OC4: Verify the Rank Nullity theorem</p> <p>OC5: Construct counterexamples related to linear transformations</p>
9	<b>Modules: - Module 1: Matrices (15 Hours)</b>	<p>(a) Systems of homogeneous and non-homogeneous linear equations, Simple examples of finding solutions of such systems. Geometric and algebraic understanding of the solutions. Algebra of solutions of systems of homogeneous linear equations. A system of homogeneous linear equations with a number of unknowns greater than the number of equations has infinitely many solutions.</p> <p>(b) Equivalence of statements (in which <math>A</math> denotes an <math>n \times n</math> matrix) such</p>

	<p>as the following.(without proof)</p> <p>(i) The system <math>Ax = b</math> of non-homogeneous linear equations has a unique solution.</p> <p>(ii) The system <math>Ax = 0</math> of homogeneous linear equations has no nontrivial solution.</p> <p>(iii) <math>A</math> is invertible.</p> <p>(iv) <math>\det A \neq 0</math>.</p> <p>(v) <math>\text{rank}(A) = n</math>.</p> <p>Examples.</p> <p>(c) Elementary matrices. Relation of elementary row operations with elementary matrices. Invertibility of elementary matrices. Consequences such as (i) a square matrix is invertible if and only if its row echelon form is invertible. (ii) Invertible matrices are products of elementary matrices. Examples of the computation of the inverse of a matrix using the Gauss elimination method.</p>
	<p><b>Module 2: Linear Transformation (15 Hours)</b></p> <p>(a) Definition of a linear transformation of vector spaces; elementary properties. Examples. Sums and scalar multiples of linear transformations. Composites of linear transformations. A Linear transformation of <math>V \rightarrow W</math>; where <math>V, W</math> are vector spaces over <math>R</math> and <math>V</math> is a finite-dimensional vector space is completely determined by its action on an ordered basis of <math>V</math>.</p> <p>(b) Null space (kernel) and the image (range) of a linear transformation. Nullity and rank of a linear transformation. Rank-Nullity Theorem (without proof).</p> <p>(c) Matrix associated with linear transformation of <math>V \rightarrow W</math> where <math>V</math> and <math>W</math> are finite dimensional vector spaces over <math>R</math>. Matrix of the composite of two linear transformations. Invertible linear transformations (isomorphisms), Linear operator, Effect of change of bases on matrices of linear operator.</p> <p>(d) Equivalence of the rank of a matrix and the rank of the associated linear transformation. Similar matrices.</p>
<b>10</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd edition, Pearson.</li> <li>2. Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).</li> <li>3. Serge Lang, Introduction to Linear Algebra, Springer.</li> <li>4. S Kumaresan, Linear Algebra: A Geometric Approach, PHI Learning.</li> <li>5. Sheldon Axler, Linear Algebra done right, Springer.</li> <li>6. Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.</li> <li>7. David W. Lewis, Matrix theory.</li> </ol>
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Matrix Analysis and its Applications, Carl D. Mayor, SIAM publications.</li> <li>2. Linear Algebra, Kenneth Hoffman &amp; Ray Kunze, Prentice-Hall Inc.</li> </ol>
	<p style="text-align: center;"><b><u>Scheme of the Examination</u></b></p>
	<p>The performance of the learners shall be evaluated in two parts.</p> <ul style="list-style-type: none"> <li>● Internal Continuous Assessment of 20 marks.</li> <li>● Semester-end examination of 30 marks.</li> <li>● A separate head of passing is required for internal and semester-end examinations.</li> </ul>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>																
<b>13</b>	<p><b>Continuous Evaluation through:</b></p> <p>Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc. (at least 3)</p> <table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Particulars</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>A class test of 10 marks is to be conducted during each semester in an Offline mode.</td> <td>10</td> </tr> <tr> <td>2</td> <td>Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.</td> <td>05</td> </tr> <tr> <td>3</td> <td>Seminar/group presentation on any one topic related to the syllabus.</td> <td>05</td> </tr> </tbody> </table> <p><b>Paper pattern of the test (offline mode with one-hour duration):</b></p> <p>Q1: Definitions/Fill in the blanks/ True or False with Justification. (04 Marks: 4 x 1).</p> <p>Q2: Attempt any two of the three descriptive questions. (06 marks: 2 × 3)</p>	Sr. No.	Particulars	Marks	1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10	2	Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.	05	3	Seminar/group presentation on any one topic related to the syllabus.	05					
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<b>14</b>	<p><b>Format of Question Paper:</b></p> <p>The semester-end examination will be of 30 marks of one-hour duration, covering the entire syllabus of the semester.</p> <table border="1"> <thead> <tr> <th colspan="4"><b>Note: Attempt any TWO questions out of THREE.</b></th> </tr> </thead> <tbody> <tr> <td>Q.No.1</td> <td>Module 1 and 2</td> <td>Attempt any <b>THREE</b> out of <b>FOUR</b>. (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5</td> <td>15 Marks</td> </tr> <tr> <td>Q.No.2</td> <td>Module 1 and 2</td> <td>Attempt any <b>THREE</b> out of <b>FOUR</b>. (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5</td> <td>15 Marks</td> </tr> <tr> <td>Q.No.3</td> <td>Module 1 and 2</td> <td>Attempt any <b>THREE</b> out of <b>FOUR</b>. (Each question of 5 marks)</td> <td>15 Marks</td> </tr> </tbody> </table>		<b>Note: Attempt any TWO questions out of THREE.</b>				Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks	Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks	Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks)	15 Marks
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## Name of the Course: PM-4B Linear Algebra (Minor II)

Sr. No.	Heading	Particulars																
1	<b>Description of the course: Including but not limited to:</b>	The system of linear equations arises naturally in other science courses. This course provides a sound knowledge of Matrix theory, starting with the basic requirement of its study in the form of solving a system of equations. Also, it advances the discussion of vector space dealing with linear transformations, developing its connection with matrix theory.																
2	<b>Vertical:</b>	Minor																
3	<b>Type:</b>	Practical																
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)																
5	<b>Hours Allotted:</b>	30 Hours																
6	<b>Marks Allotted:</b>	50 Marks																
7	<b>Course Objectives (CO):</b>	<p>This course deepens the understanding of system of linear equations with an understanding of the geometry of its solutions. Also, it covers a brief amount of matrix theory and the theory of linear transformations.</p> <p>CO1. To give sufficient knowledge of fundamental principles and methods, as well as a clear perception of numerous powers of mathematical ideas and tools and the skills to use them by modelling, solving, and interpreting.</p> <p>CO2. To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of sciences.</p> <p>CO3. To enhance students' overall development, problem-solving skills, creative talent, and the power of communication are necessary for various kinds of employment.</p> <p>CO4. To give adequate exposure to global and local concerns that would help learners explore many aspects of Mathematical Sciences.</p>																
8	<b>Course Outcomes (OC):</b>	<p>After completion of the course, students will be able to</p> <p>OC1: Calculate solutions to a system of equations using various methods, and the inverse of matrices</p> <p>OC2: Analyse the null space and rank space related to the linear transformation.</p> <p>OC3: Verify the Rank Nullity theorem</p> <p>OC4: Construct and design counterexamples related to linear transformations</p>																
9	<b>Modules: -</b> <b>Module 1: Practical for Matrices (30 Hours)</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 5%; text-align: center;">1.</td> <td>System of linear equations with examples.</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>The geometry of solutions of a system of linear equations.</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Matrix representation of a system of linear equations.</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>Algebra of solutions of a system of homogenous linear equations.</td> </tr> <tr> <td style="text-align: center;">5.</td> <td>Elementary row operations on matrices.</td> </tr> <tr> <td style="text-align: center;">6.</td> <td>Determinants and rank of a matrix.</td> </tr> <tr> <td style="text-align: center;">7.</td> <td>Solving a system of linear equations using determinants.</td> </tr> <tr> <td style="text-align: center;">8.</td> <td>Elementary matrices and their relations with elementary operations on matrices.</td> </tr> </tbody> </table>	1.	System of linear equations with examples.	2.	The geometry of solutions of a system of linear equations.	3.	Matrix representation of a system of linear equations.	4.	Algebra of solutions of a system of homogenous linear equations.	5.	Elementary row operations on matrices.	6.	Determinants and rank of a matrix.	7.	Solving a system of linear equations using determinants.	8.	Elementary matrices and their relations with elementary operations on matrices.
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	9.	Invertibility of elementary matrices.												
	10.	Computing the inverse of a matrix by the Gauss elimination method.												
<b>Module 2: Practical for Linear Transformation (30 Hours)</b>														
	1.	Linear transformations and their elementary properties.												
	2.	Composite of linear transformations.												
	3.	Determining linear transformation by knowing its action on basis vectors.												
	4.	Null space and image space of linear transformation.												
	5.	Rank and nullity of a linear transformation with verification of rank-nullity theorem.												
	6.	Computing matrix associated with a linear transformation.												
	7.	Matrix associated with a composite of two linear transformations.												
	8.	Effect on change of basis on linear transformation.												
	9.	Similar matrices.												
	10.	Equivalence of rank of a matrix with the associated linear transformation.												
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1	Objective question test	10												
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	<b>Paper pattern of the Test (Offline Mode):</b> Q1: (Attempt any 5 from 8) Multiple-													

	<p>choice questions. (10 marks: <math>5 \times 2</math>)</p> <p><b>Duration: 1Hrs</b>  <b>While setting the question paper, four MCQs on module 1 and four MCQs on module 2.</b></p>							
14	<p><b>Format of Question Paper:</b></p> <p><b>Scheme of examination:</b></p> <p>At the end of Semester IV, Practical examinations of three hours duration and 30 marks shall be conducted based on both modules.</p> <p>Paper pattern: The question paper shall have two questions.</p> <table border="1"> <tr> <td>Q. No. 1</td> <td>Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)</td> <td>Marks (<math>3 \times 5 = 15</math> Marks)</td> </tr> <tr> <td>Q. No.2</td> <td>Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)</td> <td>(<math>5 \times 2 = 10</math> Marks)</td> </tr> </table> <p><b>Marks for Journals:</b></p> <p>For both Module 1 and Module 2</p> <p>1. Journal: 5 marks (2.5 marks for each module 1 &amp; module 2)</p> <p>The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.</p>		Q. No. 1	Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks ( $3 \times 5 = 15$ Marks)	Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	( $5 \times 2 = 10$ Marks)
Q. No. 1	Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1 to OC3)	Marks ( $3 \times 5 = 15$ Marks)						
Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	( $5 \times 2 = 10$ Marks)						

**Name of the Course: Basic Mathematics in Real Life-III  
(Minor IV)**

Sr. No.	Heading	Particulars
<b>1</b>	<b>Description of the course: Including but not limited to:</b>	To underline the importance of concepts in mathematics that have physical interpretation, especially in other sciences like physics and chemistry.
<b>2</b>	<b>Vertical:</b>	Minor
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<b>Course Objectives (CO):</b>	This course emphasizes the concepts of mathematics applicable, especially in physics and chemistry. In this course, students from various science streams will be introduced to fundamental concepts from mathematics relevant to daily life and learn CO1: To identify eigenvalues and eigenvectors. CO2: To develop insight into the cross-product of vectors. CO3: To associate counting with real-life puzzles and games to make it easy to understand. CO4: recognizes symmetries in existing objects.
<b>8</b>	<b>Course Outcomes (OC):</b>	OC1: Remember and understand the concept of inner product spaces OC2: Calculate and find the inner products, moments, Eigenvalues Eigenvectors and orthogonal vectors OC3: Analyse the Cauchy-Schwarz inequality and the symmetries of triangles OC4: Verify the Cauchy-Schwarz inequality. OC5: Construct counterexamples related to inner product spaces
<b>9</b>	<b>Modules: - Module 1: Linear dependence, independence and inner product spaces (15 Hours)</b>	<ol style="list-style-type: none"> <li>1. Linear dependence and independence in two and three dimensions over reals, definitions, and simple examples.</li> <li>2. Further examples of dependence and independence.</li> <li>3. Linear dependence and independence of vectors and relation to determinants.</li> <li>4. Cross products of vectors in <math>R^3</math> basic properties like the angle between two vectors.</li> <li>5. Cross product on <math>R^3</math> and Jacobi identity; characterization of cross product is zero.</li> <li>6. Use of cross product to calculate moment about a point: definition and formula</li> <li>7. Moment of a force about a point: examples.</li> <li>8. Problems involving angle bars and estimates on the magnitude of the moment about a point.</li> <li>9. Inner product spaces definitions, examples, and properties.</li> <li>10. Arithmetic mean—geometric mean inequality: statement, proof (for two numbers only) and applications (for two or more).</li> </ol>

	<p>11. Cauchy-Schwarz inequality (real numbers) statement and proof, norm of a vector.</p> <p>12. Problems based on Cauchy-Schwarz inequality, like finding the maximum possible value of a dot product.</p> <p>13. Inner product spaces with complex coefficients.</p> <p>14. Proof of Cauchy-Schwarz inequality for complex numbers.</p> <p>15. Hermitian and unitary matrices and their examples.</p>	
	<p><b>Module 2: Eigenvalues and eigenvector orthonormalization and symmetry (15 Hours)</b></p>	
	<p>1. Definition of eigenvector and eigenvalue.</p> <p>2. Examples of eigenvector and eigenvalue in 2 by 2 matrices.</p> <p>3. Examples of eigenvectors and eigenvalues in 3 by three matrices.</p> <p>4. Gram-Schmidt orthogonalization process: formula.</p> <p>5. Gram-Schmidt orthogonalization process with examples.</p> <p>6. Playing cards and counting permutations (ordered arrangements)</p> <p>7. Further problems on cards.</p> <p>8. Set game: introduction, counting: Calculation of total number of cards, calculation of the number of sets, calculation of cards with certain properties.</p> <p>9. Permutations of an equilateral triangle.</p> <p>10. Writing composition tables for symmetries (group) of equilateral triangles.</p> <p>11. Permutation on four symbols.</p> <p>12. Rule for composition of above permutations.</p> <p>13. Symmetries of the square.</p> <p>14. Writing a composition table for symmetries of a square.</p> <p>15. Introduction to quaternions and their composition table.</p>	
<b>10</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Halliday and Resnick's Principles of Physics, Wiley, Eleventh Edition.</li> <li>Hoffman and Kunze, Linear Algebra, Second Edition, Pearson.</li> </ol>	
<b>11</b>	<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Shaeffer, R.E. <i>Elementary Structures for Architects and Builders</i>.</li> <li>Elementary Linear Algebra Application Version, H. Anton, C. Rorres, Wiley &amp; Sons.</li> </ol>	
	<p><b><u>Scheme of the Examination</u></b></p>	
	<p>The performance of the learners shall be evaluated in two parts.</p> <ul style="list-style-type: none"> <li>Internal Continuous Assessment of 20 marks.</li> <li>Semester-end examination of 30 marks.</li> <li>A separate head of passing is required for internal and semester-end examinations.</li> </ul>	
<b>12</b>	<p><b>Internal Continuous Assessment: 40%</b></p>	<p><b>Semester End Examination: 60%</b></p>

**13** **Continuous Evaluation through** Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc.  
(at least 3)

Sr. No.	Particulars	Marks
1	A class test of 10 marks is to be conducted during each semester in an Offline mode.	10
2	Project on any one topic related to the syllabus or a quiz (offline/online) on one of the modules.	05
3	Seminar/ group presentation on any one topic related to the syllabus.	05

**Paper pattern of the test (offline mode with one-hour duration):**

Q1: Definitions/Fill in the blanks/  
True or False with Justification.  
(04 Marks: 4 x 1).

Q2: Attempt two of 3 descriptive questions. (06 marks: 2 x 3)

**14** **Format of Question Paper:**  
The semester-end examination will be of 30 marks for one hour, duration covering the entire syllabus of the semester.

**Note: Attempt any TWO questions out of THREE.**

Q.No.1	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.2	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks
Q.No.3	Module 1 and 2	Attempt any <b>THREE</b> out of <b>FOUR</b> . (Each question of 5 marks) (a) Question based on OC1 (b) Question based on OC2 (c) Question based on OC3 (d) Question based on OC4/OC5	15 Marks

**Name of the Course: PM-4C Basic Mathematics in Real Life-III  
(Minor IV)**

Sr. No.	Heading	Particulars																				
1	<b>Description of the course: Including but not limited to:</b>	To underline the importance of concepts in mathematics that have physical interpretation, especially in other sciences like physics and chemistry.																				
2	<b>Vertical:</b>	Minor																				
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6	<b>Marks Allotted:</b>	50 Marks																				
7	<b>Course Objectives (CO):</b>	This course emphasizes the concepts of mathematics applicable, especially in physics and chemistry. In this course, students from various science streams will be introduced to fundamental concepts from mathematics relevant to daily life and learn CO1: To identify eigenvalues and eigenvectors. CO2: To develop insight into the cross-product of vectors. CO3: To associate counting with real-life puzzles and games to make it easy to understand. CO4: recognizes symmetries in existing objects.																				
8	<b>Course Outcomes (OC):</b>	After completion of the course, students will be able to OC1: Calculate and find the cross product, inner product, Norm, moments of force, Eigenvalues Eigenvectors and orthogonal vectors OC2: Analyse the Vector Spaces, Cauchy-Schwarz inequality and the symmetries of triangles OC3: Verify the Cauchy-Schwarz inequality and permutations as a function. OC4: Construct counterexamples related to inner product spaces.																				
9	<b>Modules: -</b>																					
	<b>Module 1: Practical for linear dependence, independence and inner product spaces (30 Hours)</b>																					
		<table border="1"> <tbody> <tr> <td>1.</td> <td>Checking Linear dependence and independence.</td> </tr> <tr> <td>2.</td> <td>Definition of Linear Span of Vectors and Examples of Finding the Span.</td> </tr> <tr> <td>3.</td> <td>Calculations based on cross product.</td> </tr> <tr> <td>4.</td> <td>Examples based on a moment about a point.</td> </tr> <tr> <td>5.</td> <td>Further computations based on cross-product.</td> </tr> <tr> <td>6.</td> <td>Verification of inner product via examples for real vector spaces.</td> </tr> <tr> <td>7.</td> <td>Norms in inner product spaces, examples and properties.</td> </tr> <tr> <td>8.</td> <td>Definition of vector space over real and complex numbers, Examples.</td> </tr> <tr> <td>9.</td> <td>Inner product spaces over complex numbers, Definition and Examples.</td> </tr> <tr> <td>10.</td> <td>Eigenvalues and Eigenvectors with basic calculations.</td> </tr> </tbody> </table>	1.	Checking Linear dependence and independence.	2.	Definition of Linear Span of Vectors and Examples of Finding the Span.	3.	Calculations based on cross product.	4.	Examples based on a moment about a point.	5.	Further computations based on cross-product.	6.	Verification of inner product via examples for real vector spaces.	7.	Norms in inner product spaces, examples and properties.	8.	Definition of vector space over real and complex numbers, Examples.	9.	Inner product spaces over complex numbers, Definition and Examples.	10.	Eigenvalues and Eigenvectors with basic calculations.
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	<b>Module 2: Practical for eigenvalues and eigenvector orthonormalisation and symmetry (30 Hours)</b>																					

	<table border="1"> <tbody> <tr><td>1.</td><td>Eigenvectors and Linear Independence.</td></tr> <tr><td>2.</td><td>Orthogonalization Formula and Examples.</td></tr> <tr><td>3.</td><td>Gram-Schmidt process with examples only of the rom real plane.</td></tr> <tr><td>4.</td><td>Gram-Schmidt process with examples in three dimensions.</td></tr> <tr><td>5.</td><td>Problems based on permutations and their composition, Examples.</td></tr> <tr><td>6.</td><td>Problems based on the formula for permutations with possible constraints.</td></tr> <tr><td>7.</td><td>Problems based on the set game.</td></tr> <tr><td>8.</td><td>Composition of two permutations and further properties.</td></tr> <tr><td>9.</td><td>Symmetries of rectangles and pentagons and other figures.</td></tr> <tr><td>10.</td><td>Symmetries of letters of the alphabet of Indian languages and English.</td></tr> </tbody> </table>	1.	Eigenvectors and Linear Independence.	2.	Orthogonalization Formula and Examples.	3.	Gram-Schmidt process with examples only of the rom real plane.	4.	Gram-Schmidt process with examples in three dimensions.	5.	Problems based on permutations and their composition, Examples.	6.	Problems based on the formula for permutations with possible constraints.	7.	Problems based on the set game.	8.	Composition of two permutations and further properties.	9.	Symmetries of rectangles and pentagons and other figures.	10.	Symmetries of letters of the alphabet of Indian languages and English.
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10	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Halliday and Resnick's Principles of Physics, Wiley, Eleventh Edition.</li> <li>Hoffman and Kunze, Linear Algebra, Second Edition, Pearson.</li> </ol>																				
11	<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Shaeffer, R.E. <i>Elementary Structures for Architects and Builders</i>.</li> <li>Elementary Linear Algebra Application Version, H. Anton, C. Rorres, Wiley &amp; Sons.</li> </ol>																				
<b><u>Scheme of the Examination</u></b>																					
12	<p><b>Internal Continuous Assessment: 40%</b></p>	<p><b>Semester End Examination: 60%</b></p>																			
13	<p><b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentations, projects, role play, creative writing, assignments, etc. (at least 3)</p> <table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Particulars</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Objective question test</td> <td>10</td> </tr> <tr> <td>2</td> <td>Overall performance</td> <td>05</td> </tr> <tr> <td>3</td> <td>Viva</td> <td>05</td> </tr> </tbody> </table> <p><b>Paper pattern of the Test (Offline Mode):</b> Q1: (Attempt any 5 from 8) Multiple-choice questions. (10 marks: 5 × 2)</p> <p><b>Duration: 1Hrs</b> <b>While setting the question paper, four MCQs in module 1 and MCQs in module 2.</b></p>	Sr. No.	Particulars	Marks	1	Objective question test	10	2	Overall performance	05	3	Viva	05								
Sr. No.	Particulars	Marks																			
1	Objective question test	10																			
2	Overall performance	05																			
3	Viva	05																			
14	<p><b>Format of Question Paper:</b> <b>Scheme of examination:</b></p> <p>At the end of Semester IV, Practical examinations of three hours duration</p>																				

and 30 marks shall be conducted based on the modules.  
Paper pattern: The question paper shall have two questions.

Q. No. 1	Five out of Eight multiple-choice questions (four from module 1 and four from module 2) (OC1, OC2 and OC 3)	Marks (3 × 5 = 15 Marks)
Q. No.2	Attempt any Two out of Four (two from module 1 and two from module 2). (OC3 and OC4)	(5 × 2 = 10 Marks)

**Marks for Journals:**

For both Module 1 and Module 2

2. Journal: 5 marks (2.5 marks for each module 1 & module 2)

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**Sd/-**  
**Sign of the BOS**  
**Chairman**  
**Prof. B.S. Desale.**  
**BOS in**  
**Mathematics**

**Sd/-**  
**Sign of the**  
**Offg. Associate Dean**  
**Dr. Madhav R. Rajwade**  
**Faculty of Science &**  
**Technology**

**Sd/-**  
**Sign of the Offg. Dean**  
**Prof. Shivram S. Garje**  
**Faculty of Science &**  
**Technology**

As Per NEP 2020

# University of Mumbai



## Syllabus for Minor Vertical 2 (Scheme-III)

Faculty of Science.

Board of Studies in Statistics.

B.A. Second Year Programme Minor - Statistics

Semester	III & IV	
Title of Paper	Sem.	Total Credits 4
I) Statistical Methods-I	III	2
II) Practical based on statistical Methods-I		2
Title of Paper		Credits
I) Statistical Methods-II	IV	2
II) Practical based on Statistical Methods-II		2
From the Academic Year		2025-26

**Semester-III**

**Minor-I**

**Name of the course: Statistical Methods -I**

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
<b>1</b>	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<b>Introduction:</b> Statistical Methods-I paper covers basic concept of probability and probability distribution which is useful to gain in-depth knowledge of probability and standard discrete distributions of other than statistics students of same faculty.
<b>2</b>	<b>Vertical :</b>	Minor
<b>3</b>	<b>Type :</b>	Theory
<b>4</b>	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted :</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks

<b>Credit:2</b>	<b>MINOR SUBJECT STATISTICAL METHODS-I</b>	<b>No. of Hours: 30</b>
	<p><b>CO2:</b> Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand the concept of probability and its applications.</li> <li>2. Differentiate between random and non-random experiment.</li> <li>3. Understand the meaning of continuous and discrete random variable.</li> <li>4. Understand discrete distributions and their properties.</li> <li>5. Solve the examples of probability</li> </ol> <p><b>OC2: On successful completion of this course Students Should be able to,</b></p> <ol style="list-style-type: none"> <li>1. Calculate probabilities and conditional probabilities.</li> <li>2. Identify the types of events.</li> <li>3. Compute the expectation of the univariate discrete random variable.</li> <li>4. Write probability mass functions (pmf) of various discrete distribution and their real-life applications.</li> <li>5. Apply the concept of probability in real-life situations.</li> </ol>	
<b>Unit</b>	<b>Elementary Probability Theory</b>	<b>Lectures</b>

I	<ul style="list-style-type: none"> <li>• Definitions: Trial, random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: compound event, complementary event, equally likely events, certain event, impossible event, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability. Properties of probability</li> <li>• Conditional probability.</li> <li>• Independence of events, pairwise and mutual independence of three events.</li> <li>• Theorems (with proof )and their applications: <ul style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ul> </li> </ul>	10
<b>Unit</b>	<b>Discrete random variables</b>	<b>Lectures</b>
II	<ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables. Definition and properties of probability mass function . cumulative distribution function.</li> <li>• Raw and Central moments (definition only) and their relationship. (up to order four).</li> <li>• Concepts of Skewness and Kurtosis and their uses for random variables.</li> <li>• Expectation and variance of a random variable. Theorems and properties on Expectation and variance of random variables with proof.</li> <li>• Joint probability mass function of two discrete random variables.</li> <li>• Marginal and conditional distributions.</li> <li>• Covariance and Coefficient of Correlation. Independence of two random variables.</li> </ul>	10
<b>Unit</b>	<b>Standard Discrete Probability Distributions</b>	<b>Lectures</b>
III	<ol style="list-style-type: none"> <li>1. Definition and derivation of mean and variance of the following distributions:</li> <li>2. Discrete Uniform distribution</li> <li>3. Bernoulli and Binomial distributions</li> <li>4. Poisson distribution</li> <li>5. Hypergeometric distribution</li> <li>6. Geometric distribution.</li> </ol>	10

	<p>7. Recurrence relation for probabilities of Binomial and Poisson distributions.</p> <p>8. Poisson approximation to Binomial distribution (only statement) and its applications.</p>	
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## Reference Books

1. David S. : Elementary Probability, Cambridge University Press.
2. Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.
3. Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillan Publishing Co. Inc.
4. Pitan Jim : Probability, Narosa Publishing House.
5. Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II : The World Press Private Limited, Calcutta.
6. Mukhopadhyay P. An Introduction to the Theory of Probability, World Scientific Publishing Company, 2011.
7. Grewal P. S, Methods of Statistical Analysis, Sterling Publishers, 1990
8. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons

## Format of Question Paper:

### Internal Continuous Assessment: (20 marks)

5Assignment/viva Quizzes, Class Tests, presentation, project, assignment etc	Class Test	Total
05	15	20

### Semester End Examination: (30 marks)

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. Examiners should frame sub questions for Q.1, Q2 and Q3. Each question carrying 15 marks. Attempt any two out of three questions.

#### Theory Question Paper Pattern:

Q 1	Max. marks: 15	Attempts any two questions out of Three.
Q 2	Max. marks: 15	
Q 3	Max. marks: 15	

**Semester-III****Minor-I****Name of the course: Practical based on Statistical Methods -I**

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
<b>1</b>	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<b>Introduction:</b> Statistical Methods-I paper covers basic concept of probability and probability distribution which is useful to gain in-depth knowledge of probability and standard discrete distributions of other than statistics students of same faculty.
<b>2</b>	<b>Vertical :</b>	Minor
<b>3</b>	<b>Type :</b>	Practical
<b>4</b>	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted :</b>	60 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks

Credit: 2	<b>Minor Practical Paper- I</b>	No. of Hours: 60
	<b>List of Practical on Statistical Methods-I</b>	
	<ol style="list-style-type: none"><li>1. Probability 1</li><li>2. Probability 2</li><li>3. Univariate Discrete random variable</li><li>4. Bivariate Discrete random variable</li><li>5. Binomial Distribution</li><li>6. Poisson Distribution</li><li>7. Hypergeometric Distribution</li><li>8. Geometric distribution.</li></ol> Practicals using EXCEL	

## Reference Books

1. Medhi J. : Statistical Methods, An Introductory Text, Second Edition, New Age International Ltd.
2. Agarwal B.L. : Basic Statistics, New Age International Ltd.
3. Spiegel M.R. : Theory and Problems of Statistics, Schaum' s Publications series. Tata McGraw-Hill.
4. Kothari C.R. : Research Methodology, Wiley Eastern Limited.
5. David S. : Elementary Probability, Cambridge University Press.
6. Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.
7. Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillan Publishing Co. Inc.
8. Pitan Jim : Probability, Narosa Publishing House.
9. Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II :The World Press Private Limited, Calcutta.
10. Elhance D. N, Elhance V, Aggarwal B. M, Fundamentals of Statistics, Kitab Mahal Daryaganaj New Delhi, 2018.
11. Mukhopadhyay P. An Introduction to the Theory of Probability, World Scientific Publishing Company, 2011.
12. Grewal P. S, Methods of Statistical Analysis, Sterling Publishers, 1990
13. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
14. Schaum Series book in O.R. Richard Bronson. 2nd edition Tata McGraw Hill Publishing Company Ltd.
15. Operations Research: Methods and Problems: Maurice Sasiemi, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.
16. Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
17. Principles of Operations Research with Applications to Management Decisions: Harvey M. Wagner, 2nd Edition, Prentice Hall of India Ltd.
18. Operations Research: S.D.Sharma. 11th edition, KedarNath Ram Nath & Company.
19. Operations Research: H. A.Taha. 6th edition, Prentice

**Format of Practical Question Paper:****Internal Practical Continuous Assessment: (20 marks)**

<b>Journal</b>	<b>Assignment/Viva</b>	<b>Total</b>
05	15	20

**Semester End Practical Examination: (30 marks)**

Semester End practical Examination will be of 30 marks of 01 hour duration covering all practical listed above of the semester. Examiners should frame questions for Q.1, Q.2 and Q.3. Each question carrying 10 marks. All questions are compulsory to solve.

**Practical Question Paper Pattern:**

Q 1	Max. marks: 10	All questions are compulsory.
Q 2	Max. marks: 10	
Q 3	Max. marks: 10	

A student must have a certified journal before appearing for the practical examination.

In case a student does not possess a certified journal, he/she is not qualified for journal 5 marks

For each paper minimum 75% of the practical must be completed to the journal certified.

**Semester-IV**  
**Minor**  
**Statistical Method-II**

Sr. No.	Heading	Particulars
1	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<b>Introduction:</b> Statistical Methods-II paper covers basic concept of probability and probability distribution which is useful to gain in-depth knowledge of probability and standard discrete distributions of other than statistics students of same faculty.
2	<b>Vertical :</b>	Minor
3	<b>Type :</b>	Theory
4	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted :</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks

Credit:2	<b>MINOR SUBJECT</b> <b>STATISTICAL METHODS-II</b>	No. of Hours:30
	<p><b>CO2:</b> Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand the fundamental concepts of continuous probability distributions.</li> <li>2. Study the concept of estimate and estimator.</li> <li>3. Understand the concept of testing of hypothesis and large sample test.</li> </ol> <p><b>OC2: Students Should be able to,</b></p> <ol style="list-style-type: none"> <li>1. Explain the continuous probability distributions such as Uniform, Exponential, Normal distributions and apply to real life applications.</li> <li>2. Compute mean, variance and standard deviations for continuous probability distributions.</li> <li>3. Apply testing of hypothesis technique to solve statistical problems.</li> </ol>	
<b>Unit</b>	<b>Continuous Probability Distributions</b>	<b>Lectures</b>

I	<ul style="list-style-type: none"> <li>• Concept of continuous random variable, probability density function and its properties. Cumulative distribution functions of continuous random variables and its properties.</li> <li>• Definition and derivation of mean, variance and median of Uniform and Exponential distributions. Memory less property of Exponential distribution.</li> <li>• Normal distribution. Properties of Normal distribution (without proof). Normal approximation to Binomial and Poisson distribution (statement only). Properties of Normal curve. Use of normal tables.</li> </ul>	10
<b>Unit</b>	<b>Estimation</b>	<b>Lectures</b>
II	<ul style="list-style-type: none"> <li>• Sampling from a distribution: Concept of a statistic, parameter, estimate and estimator, sampling distribution of statistic.</li> <li>• Concept of bias and standard error of an estimator.</li> <li>• Central Limit theorem (statement only).</li> </ul>	10
	<ul style="list-style-type: none"> <li>• Sampling distribution of sample mean and sample proportion. (For large sample only)</li> <li>• Standard errors of sample mean and sample proportion.</li> <li>• Point and Interval estimate of single mean, single proportion from sample of large size.</li> <li>• Point and interval estimate of difference between two means and proportions.</li> </ul>	
<b>Unit</b>	<b>Testing of Hypothesis and Large Sample Test</b>	<b>Lectures</b>
III	<p>Testing of hypothesis:</p> <ul style="list-style-type: none"> <li>• Concept of hypothesis</li> <li>• Simple and composite hypothesis</li> <li>• Null and alternate hypothesis</li> <li>• Test statistic, Critical region, Types of error, Level of significance and power of the test.</li> </ul> <p>Large sample tests:</p> <ul style="list-style-type: none"> <li>• For testing specific value of population mean</li> <li>• For testing specific value in difference of two means</li> <li>• For testing specific value of population proportion</li> <li>• For testing specific value of difference of population proportion (development of critical region is not expected)</li> </ul>	10

## Reference Books

1. Agarwal B. L, Basic Statistics, New Age International P Ltd. Delhi, 2015
2. Saxena S., Kapoor J. N., Mathematical Statistics, Sultan Chand & Sons, Delhi, 2010
3. Gupta S. P, Statistical Methods, Sultan Chand and Sons, New Delhi, 2002
4. Kapoor V. K, Gupta S. C, Fundamental of Mathematical Statistics, S Chand & Sons, Delhi, 2008
5. Grewal P. S. Methods of Statistical Analysis, Sterling Publishers, 1990
6. Mukhopadyay P., An Introduction to the theory of Probability, World Scientific Publishing Company, 2011

### Format of Question Paper:

#### Internal Continuous Assessment: (20 marks)

Assignment/viva Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.( at least 3 )	Class Test	Total
05	15	20

#### Semester End Examination: (30 marks)

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

#### Theory Question Paper Pattern:

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

**Semester-IV****Minor-II****Name of the course: Practical based on Statistical Methods -II**

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
<b>1</b>	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<b>Introduction:</b> Statistical Methods-II paper covers basic concept of continuous probability distribution, estimation theory and hypothesis testing methods which is useful to gain in-depth knowledge of given concept for other than statistics students of same faculty.
<b>2</b>	<b>Vertical :</b>	Minor
<b>3</b>	<b>Type :</b>	Practical
<b>4</b>	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted :</b>	60 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks

Credit: 2	<b>Minor Subject</b>  <b>Practical on Statistical Methods-II</b>	No. of Hours: 60
	<p><b>CO2:</b> Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand the fundamental concepts of continuous probability distributions.</li> <li>2. Study the concept of estimate and estimator.</li> <li>3. Understand the concept of testing of hypothesis and large sample test.</li> </ol> <p><b>OC2: Students Should be able to,</b></p> <ol style="list-style-type: none"> <li>1. Explain the continuous probability distributions such as Uniform, Exponential, Normal distributions and apply to real life applications.</li> <li>2. Compute mean, variance and standard deviations for continuous probability distributions.</li> <li>3. Apply testing of hypothesis technique to solve statistical problems.</li> </ol>	

	<b>List of Practicals on Statistical Methods -II</b>	
	<ol style="list-style-type: none"><li>1. Continuous Random Variable</li><li>2. Uniform and Exponential Distribution</li><li>3. Normal Distribution and application of central limit theorem</li><li>4. Point and Interval Estimation.</li><li>5. Testing of Hypothesis</li><li>6. Large Sample Test</li></ol> <p>Practical's using EXCEL</p>	<b>60</b>

## Reference Books

- 1 Medhi J.: Statistical Methods, An Introductory Text, Second Edition, New Age International Ltd.
- 2 Agarwal B. L.: Basic Statistics, New Age International Ltd.
- 3 Spiegel M. R.: Theory and Problems of Statistics, Schaum's Publications series. Tata McGraw-Hill.
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- 7 Goon A. M., Gupta M. K., Dasgupta B.: Fundamentals of Statistics, Volume II : The World Press Private Limited, Calcutta.
- 8 Miller I. & Miller M (2006), John E. Freund's Mathematical Statistics with applications, 7<sup>th</sup> edition, Pearson Education Asia
- 9 Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
- 10 Gupta, S. C. and Kapoor, V. K. (2004), Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
- 11 Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentice Hall of India, New D

**Format of Practical Question Paper:  
Internal Practical Continuous Assessment: (20 marks)**

<b>Journal</b>	<b>Assignment/Viva</b>	<b>Total</b>
05	15	20

**Semester End Practical Examination: (30 marks)**

Semester End practical Examination will be of 30 marks of 01 hour duration covering all practical listed above of the semester. Examiners should frame questions for Q.1, Q.2 and Q.3. Each question carrying 10 marks. All questions are compulsory to solve.

**Practical Question Paper Pattern:**

Q 1	Max. marks: 10	All questions are compulsory.
Q 2	Max. marks: 10	
Q 3	Max. marks: 10	

A student must have a certified journal before appearing for the practical examination.

In case a student does not possess a certified journal, he/she is not qualified for journal 5 marks

For each paper minimum 75% of the practical must be completed to the journal certified.

**Sd/-**  
Sign of the BOS  
Chairman  
Dr. Santosh Gite  
Board of Studies in  
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**Sd/-**  
Sign of the  
Offg. Associate Dean Dr.  
Madhav R. Rajwade  
Faculty of Science &  
Technology

**Sd/-**  
Sign of the Offg.  
Dean  
Prof. Shivram S. Garje  
Faculty of Science &  
Technology

## As Per NEP 2020

# University of Mumbai



### Syllabus for CC

**Ad- hoc Board of Studies in N.C.C./N.S.S./Sports Co-Curricular**

**UG First Year Programme – National Service Course**

<b>Semester</b>	<b>III &amp; IV</b>	
<b>Title of Paper</b>	<b>Sem</b>	<b>Credits</b>
<b>Study of Indian Social Reformers</b>	<b>III</b>	<b>2</b>
<b>Youth and Disaster Management</b>	<b>IV</b>	<b>2</b>
<b>From the Academic Year</b>		<b>2025-26</b>

# UNIVERSITY OF MUMBAI

## Semester III

(w.e.f. June, 2025)

Sub: - NSS- Study of Indian Social Reformers

Credits: 02

Lectures: 30

Marks:50

Unit Number	SEMESTER 3 Title of the Unit	No. of Lecture	No. of Credits
1	<b>History of Social work in India</b>	15	1
	Social Reformers: Definition, concept and Nature		
	History of Indian Social Reformers		
	Characteristics Indian Social Reformers - Pre-Post Independence		
	<b>Skills for NSS volunteers:</b>		
	<b>Soft Skills for NSS Volunteers</b> – Communication skills, Public speaking skills, Body Language, Content writing, Resume writing.		
	<b>Life Skills</b> – problem solving, Empathy, coping with emotions, self- Awareness and inter personal skills.		
2	<b>Contributions of Social Reformers</b>	15	1
	• Mahatma Gandhi		
	• Swami Vivekanand		
	• Sant Gadge Baba		
	• Mahatma Jyotiba Phule		
	• Rajshri Shahu Maharaj		
	• Baba Amte		
• RajaRam Mohan Roy			

### References –

- 1) Fadake G. D., (Sampadak) – Mahatma FuleSamagraWangmaya.
- 2) Salunkhe P.B., (Sampadak) – Mahatma FuleGouravGranth.
- 3) NarkeHari,(Sampadak) -Mahatma Fule :ShodhachyaNavyaWata.
- 4) Bhosale S. S., (Sampadak) –KrantiSukte: RajarshiChhatrapatiShahu
- 5) PawarJaysingrao, (Sampadak) –RajarshiShahuSmarakGranth
- 6) Dr. BabasahebAmbedkarlekhanaaniBhashanekhand 18, Bhag –1,2,3.
- 7) ToksalePrajecta -VyavysaikSamajkarya

- 8) Dr. V.C. Dande : National Service Scheme Review
- 9) Joshi V.N.-BhartiyTatvdnyanachabruhadItihas, Khand10
- 10) YadiIndumati -BharatratnaShendgeDipak (Anuwad) -MadarTeressa.
- 11) Marathi Vishwakosh, Khanda12.
- 12) Bhagat R.T. - Swami VivekanandTeAcharyaVinoba.
- 13) ShethPurushottam, KhambeteJayashri, Mane ShailajaRashtriyaSevaYojna
- 14) MishrAnupam - AajBhikharehaiTalab(Hindi)
- 15) ThotePurushottam–SamajkaryachiMultatve
- 16) Bhide G.L.,MaharashtratilSamajSudharanechaItihaas

# UNIVERSITY OF MUMBAI

## Semester IV

(w.e.f. June, 2025)

Sub: - NSS- Youth and Disaster Management

Credits: 02

Lectures: 30

Marks:50

Unit Number	SEMESTER 4 Title of the Unit	No. of Lecture	No. of Credits
1	<b>Youth and Disaster Management-</b> Meaning and Types of Disasters – Natural and Man-Made disasters, preparedness, Disaster Risk reduction: Preparedness, Mitigation, Response, Relief, Rehabilitation, Reconstruction.	10	
2	<b>Project:</b>	20	
	• Project work is mandatory for all the students in IV semester.		
	• They can carry out project work under the supervision of the teacher in-charge of NSS and at the end of the semester a project report shall be presented and viva voce shall be conducted.		
	• The Project work can be carried out independently or in a group.		
	The project work shall be community based and selected preferably from the <b>adopted villages/ slums/ neighborhoods.</b>		
<b>Project Submission and Presentation VIVA-VOCE</b>			

**Note:**

1. Above Paper will be exempted if the learner is involved in NSS as Volunteer and Successfully completes 60 hours in each Semester.
2. If learner as a NSS Volunteer attends any Camps at National/State/University/District/ College Special Camp will be exempted from either **Sem II OR Sem IV** Paper provided they produce Certificate of Participation or Attendance in Camp certified by the Programme Officer.

**Evaluation Pattern  
Internal Assessment**

Assessment Criteria	Marks
Assignment / Project / Quiz/Presentations	10
Attendance, Class and Activity Participation	10
<b>Total</b>	<b>20</b>

**External Assessment  
Question Paper Pattern**

**Time: 1:00 Hours**

**Total Marks: 30**

- Introduction:-**1. All questions are compulsory.  
2. Figure to the Right indicates full marks.  
3. Draw neat labeled drawings wherever necessary.
- 

Q.1) Rewrite the following by choosing the correct options given below  
(with four alternatives) 6 Objectives question of 1 mark each **06 marks.**

1. a)                      b)                      c)                      d)  
2. a)                      b)                      c)                      d)

Q.2) Short Notes . (Any Two out of Four) **06marks**

- 1.
- 2.
- 3.
- 4.

Q.3) Answer the following questions (Any Three out of Five) **18 marks**

- 1.
  - 2.
  - 3.
  - 4.
  - 5.
- .....

## **NSS Project Report Format**

(For Projects in Adopted Area / Village)

➤ **Cover Page**

- Name of the Institution
- Title of the Project (e.g., "Cleanliness Drive in XYZ Village")
- Name(s) of Student Volunteer(s)
- Name of Programme Officer
- Duration of the Project
- Date of Submission

➤ **Certificate**

- Issued by the Programme Officer/NSS Coordinator certifying the successful completion of the project.

➤ **Acknowledgment**

- Brief section to thank authorities, community members, NSS coordinators, peers, etc.

➤ **Index**

- A table listing all sections with corresponding page numbers.

1. Introduction
2. Profile of the Adopted Area / Village
3. Objectives of the Project
4. Planning and Preparation
5. Implementation of Activities
6. Outcomes and Impact
7. Challenges Faced
8. Feedback
9. Conclusion and Suggestions

➤ **Annexures**

- Photographs (with captions)
- Survey forms or questionnaires used
- Newspaper clippings (if any)
- Charts, posters, or flyers prepared

**Sd/-**

**Sign of the BOS  
Chairman  
Dr. Sunil Patil  
Ad-hoc Board of  
Studies in  
N.C.C./N.S.S./Sports  
Co-Curricular**

**Sd/-**

**Sign of the  
Offg. Associate Dean  
Dr. C.A.Chakradeo  
Faculty of  
Interdisciplinary  
Studies**

**Sd/-**

**Sign of the  
Offg. Associate Dean  
Dr. Kunal Ingle Faculty  
of Interdisciplinary  
Studies**

**Sd/-**

**Sign of the  
Offg. Dean  
Prof. A. K. Singh  
Faculty of  
Interdisciplinary  
Studies**

## As Per NEP 2020

### University of Mumbai



#### Title of the program

- A-** U.G. Certificate in **Computer Science**
- B-** U.G. Diploma in **Computer Science**
- C-** B.Sc. (**Computer Science**)
- D-** B.Sc. ( Hons.) in **Computer Science**
- E-** B.Sc. (Hons. with Research) in **Computer Science**

#### Syllabus for

#### Semester – I & II

**Ref: GR dated 20<sup>th</sup> April, 2023 for Credit Structure of UG**

**(With effect from the academic year 2024-25 progressively)**

# University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars	
<b>1</b>	<b>Title of program</b> O: _____ <b>A</b>	<b>A</b>	<b>U.G. Certificate in Computer Science</b>
	O: _____ <b>B</b>	<b>B</b>	<b>U.G. Diploma in Computer Science</b>
	O: _____ <b>C</b>	<b>C</b>	<b>B.Sc. (Computer Science)</b>
	O: _____ <b>D</b>	<b>D</b>	<b>B.Sc. (Hons.) in Computer Science</b>
	O: _____ <b>E</b>	<b>E</b>	<b>B.Sc. (Hons. with Research) in Computer Science</b>
<b>2</b>	<b>Eligibility</b> O: _____ <b>A</b>	<b>A</b>	<p>A candidate for being eligible for admission must have passed <b>Higher Secondary School Certificate Examination</b> (Std. XII) in <b>Science stream</b> conducted by the Maharashtra State Board of Secondary and Higher Secondary Education with <b>Mathematics and Statistics as one of the subject</b> or its equivalent. Admission will be on merit, based on order of preference as follows:</p> <ol style="list-style-type: none"> <li>1. Aggregate Marks at H.S.C. or equivalent.</li> <li>2. Aggregate Marks in Science Group (Physics, Chemistry and Mathematics)</li> <li>3. Marks in Mathematics and Statistics and Physics. Marks in Mathematics and Statistics.</li> </ol> <p style="text-align: center;"><b>OR</b></p> <p>Passed Equivalent <b>Academic Level 4.0</b> with <b>Mathematics and Statistics as one of the subject</b></p>
	O: _____ <b>B</b>	<b>B</b>	<p>Under Graduate Certificate in Computer Science</p> <p style="text-align: center;"><b>OR</b></p> <p>Passed Equivalent <b>Academic Level 4.5</b></p>
	O: _____ <b>C</b>	<b>C</b>	<p>Under Graduate Diploma in Computer Science</p> <p style="text-align: center;"><b>OR</b></p> <p>Passed Equivalent <b>Academic Level 5.0</b></p>
	O: _____ <b>D</b>	<b>D</b>	<p>Bachelors of Science in Computer Science with minimum CGPA of 7.5</p> <p style="text-align: center;"><b>OR</b></p> <p>Passed Equivalent <b>Academic Level 5.5</b></p>

	O: _____ E	E	Bachelors of Science in Computer Science with minimum CGPA of 7.5 <b>OR</b> Passed Equivalent <b>Academic Level 5.5</b>
3	Duration of program R: _____	A	One Year
		B	Two Years
		C	Three Years
		D	Four Years
		E	Four Years
4	Intake Capacity R: _____	60 students per division	
5	Scheme of Examination R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination	
6	Standards of Passing R: _____	40% in each component	
7	Credit Structure Sem. I - R: _____ A Sem. II - R: _____ B	Attached herewith	
	Credit Structure Sem. III - R: _____ C Sem. IV - R: _____ D		
	Credit Structure Sem. V - R: _____ E Sem. VI - R: _____ F		
8	Semesters	A	Sem I & II
		B	Sem III & IV
		C	Sem V & VI
		D	Sem VII & VIII
		E	Sem VII & VIII
9	Program Academic Level	A	4.5
		B	5.0
		C	5.5
		D	6.0
		E	6.0
10	Pattern	Semester	
11	Status	New	
12	To be implemented from Academic Year Progressively	From Academic Year: 2024-25	

*This syllabus is applicable to IDOL students as well, w. e. f. 2025-26.*

Sign of the BOS Chairman  
Dr. Jyotshna Dongardive  
Ad-hoc BOS (Computer Science)

Sign of the Offg. Associate Dean  
Dr. Madhav R. Rajwade  
Faculty of Science & Technology

Sign of Offg. Dean  
Prof. Shivram S. Garje  
Faculty of Science & Technology

# Preamble

## 1) Introduction

In the era of Information and Communication Technology (ICT), the transformative impact of computers on society is undeniable. The pervasive applications of computing across diverse fields have given rise to dynamic industries, evolving in tandem with the swift pace of technological change. As the landscape of the computing field continues to advance, it becomes imperative for students to cultivate a robust foundation that not only facilitates their current skills but also empowers them to adapt to the evolving nature of the field.

In line with the National Education Policy (NEP) 2020, our revised Computer Science program is designed to instill in students the ability to navigate the ever-changing technological terrain. Recognizing that specific languages and platforms may undergo transformations, the curriculum places a strong emphasis on fostering adaptability. Students will not only be exposed to a diverse array of programming languages, tools, paradigms, and technologies but will also delve into the fundamental principles that underpin the realm of computer science.

The core of our program encompasses essential courses such as programming languages, data structures, computer architecture and organization, algorithms, database systems, operating systems, and software engineering. Complementing these foundational elements are specialized courses in areas such as artificial intelligence, computer-based communication networks, distributed computing, information security, graphics, human-computer interaction, multimedia, scientific computing, web technology, and other cutting-edge topics in computer science.

### **Key Philosophy of the Program:**

- **Form Strong Foundations:** Lay the groundwork for a comprehensive understanding of Computer Science.
- **Nurture Skills:** Develop programming, analytical, and design skills to tackle real-world problems effectively.
- **Introduce Gradually:** Familiarize students with emerging trends in a gradual and coherent manner.
- **Prepare for Industry Challenges:** Groom students to meet the challenges of the ICT industry with confidence and competence.

In acknowledgement of the evolving aspirations of students, our program not only prepares them for careers in the industry but also opens doors to research opportunities. The primary goal is to deliver a modern curriculum that equips graduates with both theoretical depth and practical acumen, empowering them to excel in the workplace while fostering a mindset of lifelong learning.

This program not only paves the way for a successful career in the software industry but also inspires students to pursue further studies and research opportunities. Graduates can seamlessly transition into postgraduate programs in Computer Science, leading to research and development roles, employment in IT industries, or even a career in business management.

As we unveil this syllabus, we invite students on a journey of exploration, learning, and innovation, ensuring they are not only prepared for the present but also poised to shape the future of Computer Science.

## 2) Aims and Objectives

**Understanding and Knowledge Base:** Develop a profound understanding and knowledge of the fundamental theories, systems, and applications that form the bedrock of Computer Science. This includes establishing a strong foundation in theoretical concepts and cultivating expertise in the practical application of Computer Science theories.

**Analytical Abilities and Problem Solving:** Foster essential skills and analytical abilities required for devising computer-based solutions to real-life problems. This involves developing critical thinking skills for problem identification and analysis, as well as cultivating the ability to design and implement effective solutions using computational tools.

**Training in Emerging Technologies:** Provide training in emergent computing technologies, facilitating the development of innovative solutions for both industry and academia. This includes exposing students to cutting-edge technologies and their applications, as well as encouraging exploration and experimentation with emerging tools and platforms.

**Preparation for Post-Graduate Studies:** Develop the necessary study skills and knowledge for students to pursue further post-graduate study in Computer Science or related fields. This involves equipping students with the academic rigor required for advanced studies and fostering a passion for continuous learning and research in the field.

**Professional Skillset Development:** Develop the professional skillset required for a successful career in an information technology-oriented business or industry. This includes providing practical exposure to industry-relevant tools and practices, as well as instilling a sense of professional ethics and responsibility.

**Independent and Collaborative Work:** Enable students to work independently and collaboratively, communicate effectively, and become responsible, competent, confident, insightful, and creative users of computing technology. This involves cultivating independence in problem-solving and project execution, as well as enhancing communication and collaboration skills for effective teamwork.

### 3) Learning Outcomes

**At the end of three year Bachelor of Computer Science the students will be able:**

- Formulate, model, and design solutions and procedures, utilizing software tools to address real-world problems effectively.
- Design and develop computer programs and computer-based systems in diverse areas such as networking, web design, security, cloud computing, IoT, data science, and other emerging technologies.
- Familiarize themselves with modern-day trends in industry and research-based settings, fostering the ability to innovate novel solutions to existing problems.
- Apply concepts, principles, and theories related to computer science to new and challenging situations.
- Demonstrate proficiency in using current techniques, skills, and tools essential for computing practice.
- Apply standard Software Engineering practices and strategies in real-time software project development.
- Pursue higher studies of specialization and confidently enter technical employment.
- Work independently or collaboratively as effective team members on substantial software projects, showcasing project management and teamwork skills.
- Communicate and present their work effectively and coherently, both in oral and written formats.
- Display ethical conduct in the usage of the Internet and Cyber systems, understanding and adhering to ethical standards in computing practices.
- Engage in independent and life-long learning, adapting to the rapidly changing IT industry and staying abreast of evolving technologies.

4) Credit Structure of the Program (Sem I, II, III & IV) (Table as per Parishisht 2 with sign of HOD and Dean)

Under Graduate Certificate in Computer Science

R: _____ A										
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
4.5	I	MJ1: Digital Systems & Architecture (TH) – 2	-	-	2+2	VSC:2 Introduction to Programming with Python – 2	AEC:2, VEC:2, IKS:2	CC:2	22	UG Certificate 44
		MJ2: Fundamentals of Database Systems (TH) – 2				SEC:2 Statistics with R Programming – 2				
		MJP1: Computer Science Practical 1 (PR) – 2				OR Linux Operating System – 2				
	<b>6</b>									
R: _____ B										
4.5	II	MJ3: Design & Analysis of Algorithms (TH) – 2	-	2	2+2	VSC:2 Web Technologies – 2	AEC:2, VEC:2	CC:2	22	UG Certificate 44
		MJ4: Object Oriented Programming (TH) – 2				SEC:2 Database Management Systems using PL/SQL – 2				
		MJP2: Computer Science Practical 2 (PR) – 2				OR Advanced Python Programming – 2				
<b>6</b>										
Cum Cr.		<b>12</b>	-	<b>2</b>	<b>8</b>	<b>4+4</b>	<b>4+4+2</b>	<b>4</b>	<b>44</b>	
Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										

**Under Graduate Diploma in Computer Science**

<b>R: _____ C</b>										
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
<b>5.0</b>	<b>III</b>	<b>MJ5:</b> Principles of Operating Systems (TH) – 2	-	4	2	<b>VSC:2</b> Java Programming – 2	AEC:2	FP: 2CC:2	22	<b>UG Diploma 88</b>
		<b>MJ6:</b> Theory of Computation (TH) – 2								
		<b>MJ7:</b> Data Structures (TH) – 2								
		<b>MJP3:</b> Computer Science Practical 3 (PR) – 2								
	<b>8</b>									
<b>R: _____ D</b>										
<b>5.0</b>	<b>IV</b>	<b>MJ8:</b> Computer Networks (TH) – 2	-	4	2	<b>SEC:2</b> Mobile Application Development – 2  <b>OR</b> MEAN Stack Development – 2	AEC:2	CEP: 2 CC:2	22	<b>UG Diploma 88</b>
		<b>MJ9:</b> Software Engineering (TH) – 2								
		<b>MJ10:</b> IoT Technologies (TH) – 2								
		<b>MJP4:</b> Computer Science Practical 4 (PR) – 2								
<b>8</b>										
<b>Cum Cr.</b>		<b>28</b>	-	<b>10</b>	<b>12</b>	<b>6+6</b>	<b>8+4+2</b>	<b>8+4</b>	<b>88</b>	
<b>Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor</b>										

**B.Sc. (Computer Science)**

R: _____ E										
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
5.5	V	MJ11: Artificial Intelligence (TH) – 2	MJEL1: Software Testing & Quality Assurance (TH) – 2	4	-	VSC: 2  Ethical Hacking – 2	-	FP/CEP:2	22	UG Degree 132
		MJ12: Cyber & Information Security (TH) – 2	MJEL2: Wireless & Sensor Networks (TH) – 2							
	MJ13: Moral & Ehtical AI (TH) – 2	MJELP1: Software Testing & Quality Assurance Practical (PR) – 2								
		MJP5: Computer Science Practical 5 (PR) – 2	MJELP2: Wireless & Sensor Networks Practical (PR) – 2							
		<b>10</b>	<b>4</b>							
R: _____ F										
5.5	VI	MJ14: Data Science (TH) – 2	MJEL3: Information Retrieval (TH) – 2	4	-	-	-	OJT:4	22	UG Degree 132
		MJ15: Cloud Computing (TH) – 2	MJEL4: Linux Server Administration (TH) – 2							
	MJ16: Software Project Management (TH) – 2	MJELP3: Information Retrieval Practical (PR) – 2								
		MJP7: Computer Science Practical 6 (PR) – 2	MJELP4: Linux Server Administration Practical (PR) – 2							
		MJP8: Mini Project – II (PR) – 2								
		<b>10</b>	<b>4</b>							
	<b>Cum Cr.</b>	<b>48</b>	<b>8</b>	<b>18</b>	<b>12</b>	<b>8+6</b>	<b>8+4+2</b>	<b>8+6+4</b>	<b>132</b>	
<b>Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor</b>										

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project ]

## Semester I

Component	Major		Minor	OE	VSC	SEC	AEC	VEC	IKS	CC	Total
	Mandatory	Electives									
Credits	2+2+2	---	---	2+2	2	2	2	2	2	2	22

Component	Subject	Total Credits
Major	Digital Systems & Architecture	2
Major	Fundamentals of Database Systems	2
Major	Computer Science Practical 1	2
VSC	Introduction to Programming with Python	2
SEC (any one)	Statistics with R Programming	2
	Linux Operating System	

## Semester II

Component	Major		Minor	OE	VSC	SEC	AEC	VEC	IKS	CC2	Total
	Mandatory	Electives									
Credits	2+2+2	---	2	2+2	2	2	2	2	---	2	22

Component	Subject	Total Credits
Major	Design & Analysis of Algorithms	2
Major	Object Oriented Programming using C++	2
Major	Computer Science Practical 2	2
VSC	Web Designing	2
SEC (any one)	Database Management Systems using PL/SQL	2
	Advanced Python Programming	

**Sem – I**

## Mandatory Courses

### Name of the Course: Digital System and Architecture

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>The Digital Systems and Architecture course serves as a foundational exploration into the fundamental principles governing digital systems and computer architecture. This course delves into the design and organization of digital circuits and systems that form the backbone of modern computing devices.</p> <p><b>Relevance:</b></p> <p>In the era of rapid technological advancement, understanding digital systems and architecture is paramount. From smartphones to supercomputers, digital systems are pervasive. This course is essential for anyone aspiring to comprehend the inner workings of these systems and contribute to their development.</p> <p><b>Usefulness:</b></p> <p>The course equips students with the knowledge and skills to design, analyze, and optimize digital systems. It serves as a gateway for students to explore various aspects of computer architecture, laying the groundwork for more advanced studies and applications in the field.</p> <p><b>Application:</b></p> <p>Knowledge gained in this course finds practical applications in diverse domains, including embedded systems, computer networks, signal processing, and beyond. Students will learn how to translate theoretical concepts into tangible solutions, bridging the gap between abstraction and real-world implementation.</p> <p><b>Interest:</b></p> <p>Digital System and Architecture is an intellectually stimulating course that captivates students with its blend of theoretical concepts and hands-on application. The allure of creating efficient and high-performing digital systems often sparks curiosity and enthusiasm among students.</p> <p><b>Connection with Other Courses:</b></p> <p>This course establishes crucial linkages with other courses in computer science. It provides a solid</p>

		<p>foundation for more advanced courses such as computer organization, microprocessor systems, and hardware description languages. The knowledge gained here forms a seamless continuum in the study of computer systems.</p> <p><b>Demand in the Industry:</b></p> <p>As the demand for faster, more efficient computing systems continues to rise, professionals well-versed in digital systems and architecture are highly sought after. Industries ranging from electronics and telecommunications to automotive and healthcare actively seek individuals with expertise in designing and optimizing digital systems.</p> <p><b>Job Prospects:</b></p> <p>Graduates with proficiency in digital systems and architecture find themselves well-positioned for a myriad of career opportunities. Roles may include digital design engineer, embedded systems developer, hardware architect, and systems analyst. The skills acquired in this course open doors to a wide array of industries where digital technology plays a pivotal role.</p>
<b>2</b>	<b>Vertical:</b>	Major
<b>3</b>	<b>Type:</b>	Theory
<b>4</b>	<b>Credits:</b>	2 credits
<b>5</b>	<b>Hours Allotted:</b>	30 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To understand fundamentals of Logic gates, Number system and Flip Flops.</p> <p><b>CO 2.</b> To have an understanding of Digital System and Operation of a Digital Computer.</p> <p><b>CO 3.</b> To Learn Different Architecture &amp; Organization of memory system, processor organization and control unit.</p> <p><b>CO 4.</b> Basic understanding of 8085 microprocessor and its applications.</p>	
<b>8</b>	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Learn how number system and codes are useful in computer system design.</p> <p><b>OC 2.</b> Learn how Flip Flops are useful in memory design and data communication through CPU and Memory and I/O devices.</p> <p><b>OC 3.</b> Learn about basics of instruction sets and its types.</p> <p><b>OC 4.</b> Learn about Processor Internal Architecture and Design.</p>	

<p><b>9</b></p>	<p><b>Modules:-</b>  <b>Module 1 (15 hours):</b>  <b>Fundamentals of Digital Logic:</b> Boolean algebra, Logic Gates, Simplification of Logic Circuits: Algebraic Simplification, Karnaugh Maps.  <b>Combinational Circuits:</b> Adders, Subtractors, Multiplexer, De-Multiplexer.  <b>Sequential Circuits:</b> Flip- Flops (SR, JK &amp; D), Counters: synchronous and asynchronous Counter.  <b>Computer System:</b> Comparison of Computer Organization &amp; Architecture, Computer Components and Functions, Interconnection Structures. Bus Interconnections, Input / Output: I/O Module Programmed I/O, Interrupt Driven I/O, Direct Memory Access.</p> <hr/> <p><b>Module 2 (15 hours):</b>  <b>Memory System Organization:</b> Classification and design parameters, Memory Hierarchy, Internal Memory: RAM, SRAM and DRAM, Interleaved and Associative Memory. Cache Memory: Design Principles, Memory mappings, Replacement Algorithms, Cache performance, Cache Coherence. Virtual Memory, External Memory: Magnetic Discs, Optical Memory, Flash Memories, RAID Levels  <b>Instructions:</b> Instruction Formats, Instruction Sets, Addressing Modes, Addressing Modes Examples with Assembly Language [8085/8086 CPU].  <b>Processor Organization:</b> Structure and Function. Register Organization [8085/8086 CPU]. Basic Microprocessor operations: Data Transfer (Register / Memory) Operations, Arithmetic &amp; Logical Operations.  Instruction Cycle, Instruction Pipelining. Introduction to RISC and CISC Architecture, Instruction Level Parallelism and Superscalar Processors, Design Issues.</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. M. Mano, Computer System Architecture 3rd edition, Pearson</li> <li>2. Carl Hamacher et al., Computer Organization and Embedded Systems, 6 ed., McGraw-Hill 2012</li> <li>3. R P Jain, Modern Digital Electronics, Tata McGraw Hill Education Pvt. Ltd. , 4th Edition, 2010</li> </ol>
<p><b>11</b></p>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. William Stallings (2010), Computer Organization and Architecture-designing for performance, 8th edition, Prentice Hall, New Jersey.</li> <li>2. Anrew S. Tanenbaum (2006), Structured Computer Organization, 5th edition, Pearson Education Inc,</li> <li>3. John P. Hayes (1998), Computer Architecture and Organization, 3rd edition, Tata McGrawHill</li> <li>4. Ramesh Gaonkar (2013), Microprocessor Architecture, Programming and Application with 8085, 6<sup>th</sup> edition, Penram.</li> </ol>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>																
<b>13</b>	<b>Continuous Evaluation through:</b> Class Test on Module 1: 10 marks Class Test on Module 2: 10 marks <hr/> <b>Average of 2 Class Tests: 10 marks</b> Assignment on Module 1: 5 marks Assignment on Module 2: 5 marks <hr/> <b>Total of 2 Assignments: 10 marks</b> <b>Total: 20 marks</b>	<b>Evaluation through:</b> A <b>Semester End Theory Examination</b> of <b>1 hour duration</b> for <b>30 marks</b> as per the paper pattern given below. <hr/> <b>Total: 30 marks</b>																
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## Name of the Course: Fundamentals of Database Systems

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Fundamentals of Database Systems course is a foundation in the study of information management and technology. It provides students with a comprehensive understanding of the principles, design, and implementation of databases, which are critical components in virtually every domain where data is utilized.</p> <p><b>Relevance:</b></p> <p>In today's data-driven world, the management and retrieval of information are paramount. This course is highly relevant as it addresses the core concepts essential for organizing, storing, and manipulating data efficiently.</p> <p><b>Usefulness:</b></p> <p>This course is immensely useful for individuals aspiring to work with data in various capacities. Whether designing databases, developing applications that interact with databases, or analyzing data trends, a solid understanding of database fundamentals is crucial.</p> <p><b>Application:</b></p> <p>The principles learned in this course find application across diverse sectors, including business, healthcare, finance, and technology. Students will gain the skills to model real-world scenarios, design efficient databases, and implement systems that store and retrieve information seamlessly.</p> <p><b>Interest:</b></p> <p>This course often attracts students due to its practical and tangible applications. The ability to structure and manage data effectively, ensuring its integrity and accessibility, can be intellectually stimulating and applicable to numerous real-world scenarios.</p> <p><b>Connection with Other Courses:</b></p> <p>This course forms a vital connection with various other courses in computer science and information technology. It is foundational to courses like database management, data warehousing, and data mining. Additionally, it complements courses related to software development, ensuring a holistic understanding of system architecture.</p>

		<p><b>Demand in the Industry:</b></p> <p>As businesses and organizations amass ever-growing volumes of data, there is an increasing demand for professionals versed in database systems. Industries such as finance, healthcare, e-commerce, and technology actively seek individuals who can design, implement, and manage robust databases.</p> <p><b>Job Prospects:</b></p> <p>Graduates proficient in the fundamentals of database systems enjoy promising job prospects. Potential roles include database administrator, data analyst, database developer, and business intelligence analyst. These professionals play a pivotal role in ensuring the efficient and secure management of an organization's data assets.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory)
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To make students aware fundamentals of database system.</p> <p><b>CO 2.</b> To give idea how ERD components helpful in database design and implementation.</p> <p><b>CO 3.</b> To experience the students working with database using MySQL.</p> <p><b>CO 4.</b> To familiarize the student with normalization, database protection and different DCL Statements.</p> <p><b>CO 5.</b> To make students aware about importance of protecting data from unauthorized users.</p> <p><b>CO 6.</b> To make students aware of granting and revoking rights of data manipulation.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p>After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> To appreciate the importance of database design.</p> <p><b>OC 2.</b> Analyze database requirements and determine the entities involved in the system and their relationship to one another.</p> <p><b>OC 3.</b> Write simple queries to MySQL related to String, Maths and Date Functions.</p> <p><b>OC 4.</b> Create tables and insert/update/delete data, and query data in a relational DBMS using MySQL commands.</p> <p><b>OC 5.</b> Understand the normalization and its role in the database design process.</p> <p><b>OC 6.</b> Handle data permissions.</p> <p><b>OC 7.</b> Create indexes and understands the role of Indexes in optimization search.</p>	

<b>9</b>	<p><b>Modules</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to DBMS:</b> Database, DBMS – Definition, Overview of DBMS, Advantages of DBMS, Levels of abstraction, Data independence, DBMS Architecture</p> <p><b>Data models:</b> Client/Server Architecture, Object Based Logical Model, Record Based Logical Model (relational, hierarchical, network)</p> <p><b>Entity Relationship Model and ER to Table:</b> Entities, attributes, entity sets, relations, relationship sets, Additional constraints (key constraints, participation constraints, weak entities, aggregation / generalization, Conceptual Design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER) Entity to Table, Relationship to tables with and without key constraints.</p> <p><b>DDL Statements:</b> Creating Databases, Using Databases, datatypes, Creating Tables (with integrity constraints – primary key, default, check, not null), Altering Tables, Renaming Tables, Dropping Tables, Truncating Tables</p> <p><b>DML statements:</b> Viewing the structure of a table insert, update, delete, Select all columns, specific columns, unique records, conditional select, in clause, between clause, limit, aggregate functions (count, min, max, avg, sum), group by clause, having clause</p> <hr/> <p><b>Module 2 (15 hours):</b></p> <p><b>Relational data model:</b> Domains, attributes, Tuples and Relations, Relational Model Notation, Characteristics of Relations, Relational Constraints - primary key, referential integrity, unique constraint, Null constraint, Check constraint</p> <p><b>Functions:</b> String Functions (concat, instr, left, right, mid, length, lcase/lower, ucase/upper, replace, strcmp, trim, ltrim, rtrim), Math Functions (abs, ceil, floor, mod, pow, sqrt, round, truncate) Date Functions(adddate, datediff, day, month, year, hour, min, sec, now, reverse)</p> <p><b>Joining Tables and Subqueries:</b> inner join, outer join (left outer, right outer, full outer)</p> <p>subqueries with IN, EXISTS, subqueries restrictions, Nested subqueries, ANY/ALL clause, correlated subqueries</p> <p><b>Normal forms:</b> Functional dependencies, first, second, third, and BCNF normal forms based on primary keys, lossless join decomposition.</p> <p><b>Database Protection:</b> Security Issues, Threats to Databases, Security Mechanisms, Role of DBA, Discretionary Access Control, Backing Up and Restoring databases</p> <p><b>Views:</b> Creating, altering dropping, renaming and manipulating views</p> <p><b>DCL Statements:</b> Creating/dropping users, privileges introduction, granting/revoking privileges, viewing privileges), Transaction control commands – Commit, Rollback</p>
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<b>10</b>	<b>Text Books</b> 1. Fundamentals of Database System, ElmasriRamez, NavatheShamkant, Pearson Education, Seventh edition, 2017 2. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition,2014 3. Murach's MySQL, Joel Murach, 3rd Edition, 3rd Edition, 2019																		
<b>11</b>	<b>Reference Books</b> 1. Database System Concepts, Abraham Silberschatz, HenryF.Korth, S.Sudarshan, McGraw Hill,2017 2. MySQL: The Complete Reference, VikramVaswani , McGraw Hill, 2017 3. Learn SQL with MySQL: Retrieve and Manipulate Data Using SQL Commands with Ease, Ashwin Pajankar, BPB Publications, 2020																		
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## Name of the Course: Computer Science Practical 1

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>The Major Computer Science Practical Course, encompassing Digital Systems and Architecture as well as Database Systems, is a comprehensive and hands-on exploration into the foundational aspects of both hardware and software that underpin modern computing. This practical course is designed to provide students with a holistic understanding of digital systems, computer architecture, and the effective management of data within databases.</p> <p><b>Relevance:</b></p> <p>In an era where seamless integration of hardware and software is pivotal, the combination of Digital Systems and Architecture with Database Systems is highly relevant. This practical course addresses the symbiotic relationship between the two, offering students a holistic perspective on building robust computing solutions.</p> <p><b>Usefulness:</b></p> <p>This course is immensely useful for students aiming to bridge the gap between hardware and software. By integrating digital systems with database concepts, students gain a unique skill set that enables them to design, implement, and optimize computing systems comprehensively.</p> <p><b>Application:</b></p> <p>The skills acquired in this practical course find direct application in the development of efficient and integrated computing solutions. Students learn to design digital systems, optimize hardware performance, and seamlessly integrate these systems with databases to handle and manipulate data effectively.</p> <p><b>Interest:</b></p> <p>The Major Computer Science Practical Course is designed to spark interest by offering a hands-on approach to both hardware and software components. Students engage in practical exercises that involve designing digital circuits, implementing database solutions, and integrating these components, fostering a deeper understanding and appreciation for the intricacies of computing systems.</p>

		<p><b>Connection with Other Courses:</b></p> <p>This practical course serves as a nexus, connecting various other courses in the computer science curriculum. It lays a foundation for advanced courses in computer organization, embedded systems, software engineering, and database management. The integrated approach ensures students comprehend the synergies between different aspects of computer science.</p> <p><b>Demand in the Industry:</b></p> <p>Professionals who can seamlessly navigate both digital systems and database management are in high demand. Industries ranging from electronics and telecommunications to software development and data analytics actively seek individuals proficient in both hardware and software aspects, recognizing the practical value of this dual expertise.</p> <p><b>Job Prospects:</b></p> <p>Graduates from this practical course enjoy promising job prospects in roles that require a holistic understanding of computing systems. Potential job titles include systems architect, database administrator, embedded systems developer, and hardware-software integration specialist. These professionals are well-positioned to contribute to diverse industries seeking comprehensive computing solutions.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits (1 credit = 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	60 hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To verify the truth tables of various logic gates</p> <p><b>CO 2.</b> Develop proficiency in designing and implementing digital circuits.</p> <p><b>CO 3.</b> Explore various components of digital systems, including processors, memory units, and input/output interfaces.</p> <p><b>CO 4.</b> Develop skills in designing and creating relational databases.</p> <p><b>CO 5.</b> Explore the principles of database querying using SQL.</p> <p><b>CO 6.</b> Gain practical knowledge of transaction management and data control in database systems.</p>	

8	<p><b>Course Outcomes (OC):</b>  After successful completion of this course, students would be able to -</p> <p><b>OC 1.</b> Verify truth tables of various logic gates</p> <p><b>OC 2.</b> Simplify given Boolean expressions and implement them using Logisim.</p> <p><b>OC 3.</b> Design and validate the operation of various combinational circuits using Logisim.</p> <p><b>OC 4.</b> Understand the behavior and applications of flip-flops in digital systems.</p> <p><b>OC 5.</b> Design and implement expressions using multiplexers/demultiplexers in Logisim.</p> <p><b>OC 6.</b> Create and maintain relational databases, applying normalization principles.</p> <p><b>OC 7.</b> Write simple queries to MySQL related to String, Maths and Date Functions.</p> <p><b>OC 8.</b> Create tables and insert/update/delete data, and query data in a relational DBMS using MySQL commands.</p> <p><b>OC 9.</b> Handle data permissions.</p>
9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <hr/> <p><b>Digital Systems &amp; Architecture – Practical</b></p> <hr/> <p><b>Logic Gates Truth Table Verification:</b>  Study and verify the truth table of various logic gates (NOT, AND, OR, NAND, NOR, EX-OR, EX-NOR) using Logisim.</p> <p><b>Boolean Expression Simplification:</b>  Simplify given Boolean expressions and realize them using Logisim.</p> <p><b>Half/Full Adder Design:</b>  Design and verify the operation of a half/full adder using Logisim.</p> <p><b>Half/Full Subtractor Design:</b>  Design and verify the operation of a half/full subtractor using Logisim.</p> <p><b>4-Bit Magnitude Comparator:</b>  Design a 4-bit magnitude comparator using combinational circuits in Logisim.</p> <p><b>Flip-Flop Implementation:</b>  Verify the operation of flip-flops (e.g., D, JK) using logic gates in Logisim.</p> <p><b>Counter Operation Verification:</b>  Verify the operation of a counter using Logisim.</p> <p><b>4-Bit Shift Register Operation:</b>  Verify the operation of a 4-bit shift register using Logisim.</p> <p><b>Multiplexer/Demultiplexer Design:</b>  Design and implement expressions using multiplexers/demultiplexers in Logisim.</p>

**3-Bit Binary Ripple Counter:**

Design and implement a 3-bit binary ripple counter using JK flip-flops in Logisim. The above practical can be performed using any open source simulator (like Logisim) (Download it from <https://sourceforge.net/projects/circuit/>)

**Module 2 (30 hours):****Fundamentals of Database Systems – Practical****Conceptual Design Using ER Diagrams:**

Identify entities, attributes, keys, and relationships. Apply generalization and specialization.

**Database Management Operations:**

View all databases, create a database, view all tables in a database, create tables with and without constraints, perform CRUD operations.

**Table Management Operations:**

Alter a table, drop/truncate/rename tables, perform backup/restore operations on a database.

**Basic Queries and Aggregate Functions:**

Execute simple queries and utilize aggregate functions (e.g., COUNT, SUM, AVG).

**Advanced Query Functions:**

Utilize date, string, and math functions in queries.

**Join Queries:**

Execute inner and outer join queries.

**Subqueries:**

Apply subqueries with IN and EXISTS clauses.

**ER Model to Relational Model Conversion and Normalization:**

Convert ER model to a relational model and apply normalization up to 3rd Normal Form.

**Views:**

Create views with and without check options, drop views, select data from views.

**Data Control Language (DCL) Statements:**

Implement DCL statements for granting and revoking permissions. Demonstrate COMMIT and ROLLBACK statements.

These experiments can be implemented using a database management system like MySQL.

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<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 100 marks, should be scaled down to a final score of 20 marks.  <hr/> <b>Total: 20 marks</b>	<b>A Semester End Practical Examination of 2 hours duration for 30 marks</b> as per the paper pattern given below.  <b>Certified Journal is compulsory</b> for appearing at the time of Practical Exam  <hr/> <b>Total: 30 Marks</b>												
<b>14</b>	<b>Format of Question Paper:</b>  <b>Total Marks: 30</b> <span style="float: right;"><b>Duration: 2 Hours</b></span> <table border="1"> <thead> <tr> <th>Question</th> <th>Practical Question Based On</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>Q. 1</td> <td>Module 1</td> <td>12</td> </tr> <tr> <td>Q. 2</td> <td>Module 2</td> <td>12</td> </tr> <tr> <td>Q. 3</td> <td>Viva</td> <td>06</td> </tr> </tbody> </table>		Question	Practical Question Based On	Marks	Q. 1	Module 1	12	Q. 2	Module 2	12	Q. 3	Viva	06
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## Vocational & Skill Enhancement Courses (VSEC)

### Name of the Course: Introduction to Programming with Python

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>Introduction to Programming with Python Course serves as an entry point into the world of coding, introducing learners to the versatile and beginner-friendly Python language. Python is renowned for its readability and simplicity, making it an ideal choice for individuals taking their first steps in programming.</p> <p><b>Relevance:</b></p> <p>In today's digital era, programming skills are increasingly essential across various disciplines. Python, being an interpreted, high-level language, is relevant for diverse applications, from web development and data analysis to artificial intelligence and automation.</p> <p><b>Usefulness:</b></p> <p>The course provides a foundational understanding of Python syntax, data structures, and control flow, empowering learners to write functional and efficient code. Python's broad applicability makes the skills acquired in this course valuable for numerous programming tasks.</p> <p><b>Application:</b></p> <p>Upon completion, participants can apply Python to solve real-world problems, automate repetitive tasks, and create simple applications. The practical knowledge gained serves as a stepping stone for more advanced Python courses or specialization in areas like data science or web development.</p> <p><b>Interest:</b></p> <p>Python's user-friendly syntax and extensive libraries make it an enjoyable language for beginners. The course is designed to spark interest by combining theory with hands-on projects, fostering a passion for coding and problem-solving.</p> <p><b>Connection with Other Courses:</b></p> <p>Python is a gateway language that seamlessly integrates with other programming languages and technologies. The skills acquired in a Basic Python Programming Course</p>

		<p>provide a solid foundation for advanced programming languages and specialized courses in data science, machine learning, and more.</p> <p><b>Demand in the Industry:</b></p> <p>Python's popularity in the industry is soaring. Its versatility, readability, and extensive community support have led to its widespread adoption. Professionals proficient in Python are in high demand across various sectors, including technology, finance, healthcare, and academia.</p> <p><b>Job Prospects:</b></p> <p>Completion of this Course opens doors to entry-level positions in software development, quality assurance, data analysis, and scripting. Python developers are sought after for their ability to quickly prototype solutions and contribute to various stages of software development.</p>
2	<b>Vertical:</b>	VSC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> Master Python features, execution, and diverse data types.</p> <p><b>CO 2.</b> Demonstrate expertise in if statements, loops, and control statements.</p> <p><b>CO 3.</b> Efficiently create and manipulate arrays, strings, and data structures.</p> <p><b>CO 4.</b> Apply functions, modules, and strings for versatile programming tasks.</p> <p><b>CO 5.</b> Effectively manage files, utilize regular expressions, and work with date and time.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Apply Python features for diverse programming tasks confidently.</p> <p><b>OC 2.</b> Implement control flow statements for precise program execution.</p> <p><b>OC 3.</b> Manipulate arrays, strings, and data structures with precision and ease.</p> <p><b>OC 4.</b> Create modular, efficient code using functions, modules, and strings.</p> <p><b>OC 5.</b> Skillfully manage files, utilize regular expressions, and work with date and time for program efficiency.</p>	
9	<p><b>Modules:-</b></p> <p><b>Module (30 hours):</b></p> <p><b>Overview and Basic Elements of Python Programming:</b> Features of Python, Execution of a Python Program, Flavours of Python, Innards of Python, Python Interpreter, Comments, Docstrings, IDLE, Data types, Dictionary, Sets, Mapping, Basic Elements of Python, Variables, Input Function, Output Statements, Command</p>	

	<p>Line Arguments. Operators, Precedence of Operators, Associativity of Operators</p> <p><b>Control Statements:</b> The if statement, The if ... else Statement, The if ... elif ... else Statement, Loop Statement- while loop, for loop, Infinite loop, Nested loop, The else suite, break statement, continue statement, pass statement, assert statement, return statement.</p> <p><b>Arrays:</b> Creating Arrays, Indexing and Slicing of Arrays, Basic Array Operations, Arrays Processing, Mathematical Operations on Array, Aliasing Arrays, Slicing and Indexing in NumPy Arrays, Basic slicing, Advanced Indexing, Dimensions and Attributes of an Array</p> <p><b>Functions:</b> Function definition and call, Returning Results, Returning Multiple Values from a Function, Built-in Functions, Difference between a Function and a Method, Pass Value by Object Reference, Parameters and Arguments, Recursive Functions, Anonymous or Lambda Functions. Modules in Python.</p> <p><b>Strings:</b> Creating Strings, Functions of Strings, Working with Strings, Formatting Strings, Finding the Number of Characters and Words, Inserting Substrings into a String.</p>
	<p><b>Module (30 hours):</b></p>
	<p><b>Exploring List, Tuples and Dictionaries:</b> Lists, List Functions and Methods, List Operations, List Slices, Nested Lists, Tuples, Functions in Tuple.</p> <p><b>Working with Dictionaries:</b> Creating a Dictionary, Operators in Dictionary, Dictionary Methods, Using for Loop with Dictionaries, Operations on Dictionaries</p> <p><b>Files in Python:</b> Opening and Closing a File, Working with Text Files, , Working with Binary Files, The ‘with’ statement, Pickle in Python, The seek() and tell() Methods, Random Accessing of Binary Files, Zipping and Unzipping Files, Working with Directories</p> <p><b>Regular Expressions:</b> Introduction, Sequence Characters in Regular Expressions, Special Characters in Regular Expressions, Using Regular Expression on Files, Retrieving Information from an HTML File</p> <p><b>Date And Time in Python:</b> Time, Date, Date and Time Now, combining date and times, formatting date and time, Finding and comparing dates, Sorting dates, Knowing the Time taken by a Program, Working with Calendar Module</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Practical Programming: An Introduction to Computer Science Using Python 3, Paul Gries , Jennifer Campbell, Jason Montojo, Pragmatic Bookshelf, 2nd Edition, 2014</li> <li>2. Programming through Python, M. T Savaliya, R. K. Maurya &amp; G M Magar, Sybgen Learning India, 2020</li> </ol>
<p><b>11</b></p>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Python: The Complete Reference, Martin C. Brown, McGraw Hill, 2018</li> <li>2. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress, 2017</li> </ol>

	3. Programming in Python 3, Mark Summerfield, Pearson Education, 2nd Ed, 2018 4. Python Programming: Using Problem Solving Approach, ReemaThareja, Oxford Univeristy Press, 2017 5. Let Us Python, Yashwant. B. Kanetkar, BPB Publication, 2019													
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks. <hr/> <b>Total: 20 marks</b>	<b>A Semester End Practical Examination of 2 hours duration for 30 marks</b> as per the paper pattern given below.  <b>Certified Journal is compulsory</b> for appearing at the time of Practical Exam <hr/> <b>Total: 30 Marks</b>												
<b>14</b>	<b>Format of Question Paper:</b>  <div style="display: flex; justify-content: space-between;"> <span><b>Total Marks: 30</b></span> <span><b>Duration: 2 Hours</b></span> </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">Question</th> <th style="width: 40%;">Practical Question Based On</th> <th style="width: 30%;">Marks</th> </tr> </thead> <tbody> <tr> <td><b>Q. 1</b></td> <td>Module 1</td> <td>12</td> </tr> <tr> <td><b>Q. 2</b></td> <td>Module 2</td> <td>12</td> </tr> <tr> <td><b>Q. 3</b></td> <td>Viva</td> <td>06</td> </tr> </tbody> </table>		Question	Practical Question Based On	Marks	<b>Q. 1</b>	Module 1	12	<b>Q. 2</b>	Module 2	12	<b>Q. 3</b>	Viva	06
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<b>Q. 1</b>	Module 1	12												
<b>Q. 2</b>	Module 2	12												
<b>Q. 3</b>	Viva	06												

## Name of the Course: Statistics with R Programming

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>This course provides an immersive exploration into the world of statistical computing and data analysis. Developed specifically for statistical computing and graphics, R is an open-source language that has become a standard tool for professionals in various fields.</p> <p><b>Relevance:</b></p> <p>In the era of big data and analytics, R programming is highly relevant. It is widely used for statistical modeling, data visualization, and machine learning, making it an indispensable skill for individuals in data-centric roles.</p> <p><b>Usefulness:</b></p> <p>The course equips participants with the ability to manipulate data, perform statistical analyses, and create visualizations. R's versatility makes it valuable for both beginners entering the field and seasoned professionals enhancing their analytical toolkit.</p> <p><b>Application:</b></p> <p>R programming finds application across diverse domains, including finance, healthcare, marketing, and academia. Participants can apply R to solve real-world problems, extract insights from data, and make informed decisions.</p> <p><b>Interest:</b></p> <p>The R programming course often sparks interest due to its hands-on nature. Participants engage in practical exercises, exploring datasets, creating visualizations, and developing statistical models, fostering a deep understanding of data analytics.</p> <p><b>Connection with Other Courses:</b></p> <p>This course forms a symbiotic connection with other data-centric courses. It complements studies in statistics, machine learning, and data science, providing a foundation for advanced analytics.</p> <p><b>Demand in the Industry:</b></p> <p>Professionals with R programming skills are in high demand. Industries ranging from finance to healthcare seek individuals who can leverage R for data analysis and</p>

		<p>decision-making, contributing to evidence-based practices.</p> <p><b>Job Prospects:</b></p> <p>Graduates from an R programming course find diverse job prospects. Roles may include data analyst, statistician, business intelligence analyst, and data scientist. These professionals are sought after for their ability to derive actionable insights from data.</p>
2	<b>Vertical:</b>	SEC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> Understand R basics, set up R Studio, and customize the environment..</p> <p><b>CO 2.</b> Master R expressions, assignments, loops, and decision-making.</p> <p><b>CO 3.</b> Develop proficiency in using R data structures: vectors, matrices, lists, and data frames.</p> <p><b>CO 4.</b> Demonstrate expertise in character strings manipulation in R.</p> <p><b>CO 5.</b> Apply built-in statistical functions, regression analysis, and distribution functions fluently.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Confidently navigate Studio, R GUI, and manage data in R.</p> <p><b>OC 2.</b> Fluent implementation of expressions, assignments, and loops in R.</p> <p><b>OC 3.</b> Use R data structures for effective data management.</p> <p><b>OC 4.</b> Efficiently manipulate and operate on character strings in R.</p> <p><b>OC 5.</b> Apply statistical functions, regression analysis, and distribution functions with confidence.</p>	
9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>Exploring R Language and Setting Up environment:</b> Introduction to R, Terminologies in R, R Environment, Installing R, Studio, and R Commander, Customizing Studio, Data Management in Studio, R Graphical User Interface (R GUI), Working with R Scripts</p> <p><b>Implementing Expression:</b> Expressions, assignment, Decision making, Loops, data and time options in R</p> <p><b>Essential Data Structures in R:</b> Vectors, Matrix, Arrays, Lists, Data frames, Functions</p> <p><b>Implementing Strings in R:</b> Character strings in R, Character Strings, , Strings and R objects, String Manipulation: Printing Characters, Basic String Manipulations, String Operations</p>	

	<b>Module 2 (30 hours):</b>													
	<p><b>Built-in statistical functions in R:</b> mean() function, Median, Standard Deviation, Some other built-in statistical functions,</p> <p><b>Regression Analysis:</b> Regression Analysis-Linear Regression and Multiple Regression, Normal Distribution- dnorm(),pnorm(),qnorm(),rnorm()</p> <p><b>Binomial Distribution:</b> dbinom(),pbinom(),qbinom(),rbinom() Functions, Time Series Analysis</p> <p><b>Visualizing and analysing Data in R:</b> Tabulation, Contingency Tables, Making R Contingency Tables, Making R Custom Contingency Tables, Selection of Parts in a Table Object, Conversion of an Object into the Table, Testing Table Objects, Making R Complex Tables, Representing data through Cross Tabulation</p> <p><b>Graphical Models &amp; analysis:</b> Plots made of Single Plots made of Two Variables , Variable, Plots made of Multiple Variables, Special Plots, Storing Graphics</p>													
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Statistical Programming in R, K.G. Srinivasa G.M. Siddesh,Chetan Shetty , Oxford University Press, 2017</li> <li>2. Learning R: A Language for Data Analytics and Visualization, Sybgen Learning, R. K. Maurya, 2021</li> <li>3. Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R: Heumann, Christian, Schomaker, Michael, Shalabh, Publisher” Springer 2016</li> </ol>													
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Learning R Programming, Kun Ren, Packt Publishing, 2018</li> <li>2. R Programming for Statistics and Data Science(Video), 365 Careers, Packt, 2018</li> <li>3. R Programming Fundamentals, Kaelen Medeiros, Oreily-Packt Publishing</li> </ol>													
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	<p>The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks.</p> <hr/> <p><b>Total: 20 marks</b></p>	<p><b>A Semester End Practical Examination of 2 hours duration for 30 marks</b> as per the paper pattern given below.</p> <p><b>Certified Journal is compulsory</b> for appearing at the time of Practical Exam</p> <hr/> <p><b>Total: 30 Marks</b></p>												
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Q. 3	Viva	06												

## Name of the Course: LINUX Operating System

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Linux Operating System course is a foundational exploration into the world of computing, providing students with essential knowledge about this open-source and widely used operating system.</p> <p><b>Relevance:</b></p> <p>Linux is integral to various industries, from server administration to software development, cybersecurity, cloud computing, and IoT, making the course highly relevant in today's digital landscape.</p> <p><b>Usefulness:</b></p> <p>Linux dominates global server environments, making it a crucial skill for managing and maintaining servers efficiently. Many development tools and environments are Linux-based, enhancing a developer's capabilities. Linux, well-known for its robust security features, plays a pivotal role in the field of cybersecurity, making Linux knowledge invaluable for professionals in this domain. Popular cloud platforms extensively use Linux, making familiarity with it beneficial for cloud administrators. Linux's prevalence in IoT devices and embedded systems underscores its importance for professionals working in these emerging fields.</p> <p><b>Application:</b></p> <p>The course introduces students to the core principles and practical applications of Linux, covering areas such as server administration, software development, cybersecurity, cloud computing, and IoT.</p> <p><b>Interest:</b></p> <p>With its open-source nature and versatile applications, Linux attracts individuals who appreciate efficient command-line tools and those interested in stability, reliability, and the command-line interface.</p> <p><b>Connection with Other Courses:</b></p> <p>The course seamlessly integrates with network administration courses by incorporating essential Linux commands. It also aligns with various software development courses, fostering a comprehensive</p>

		<p>understanding of computing environments.</p> <p><b>Demand in the Industry:</b></p> <p>The industry recognizes the stability, security, and cost-effectiveness of Linux, resulting in a consistently high demand for professionals with Linux expertise.</p> <p><b>Job Prospects:</b></p> <p>Graduates of the Linux Operating System course are well-positioned for diverse roles, including system administrators, network administrators, DevOps engineers, cloud administrators, cybersecurity analysts, and software developers.</p>
2	<b>Vertical:</b>	SEC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To learn basic concepts of Linux in terms of operating system</p> <p><b>CO 2.</b> To learn use of various shell commands with regular expressions</p> <p><b>CO 3.</b> To set Linux Environment variables and learn setting file permissions to maintain Linux security implementation</p> <p><b>CO 4.</b> To learn various editors available in Linux OS and learn shell scripting.</p> <p><b>CO 5.</b> To learn installation of compilers and programming using C and Python languages on Linux platform.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Work with Linux file system structure, Linux Environment</p> <p><b>OC 2.</b> Handle shell commands for scripting, with features of regular expressions, redirections</p> <p><b>OC 3.</b> Implement file security permissions</p> <p><b>OC 4.</b> Work with vi, sed and awk editors for shell scripting using various control structures</p> <p><b>OC 5.</b> Install software like compilers and develop programs in C and Python programming languages on Linux Platform</p>	
9	<p><b>Modules:-</b></p> <p><b>Module (30 hours):</b></p> <p><b>Introduction to Linux Operating System and Basics:</b> History of Linux, GNU Info and Utilities, Various Linux Distributions, The Unix/Linux architecture, Features of Unix/Linux</p> <p><b>Installation of Ubuntu Linux Operating System:</b> Booting and Installing from USB/DVD, Using Ubuntu Software Center / Using Synaptic, Exploring useful</p>	

	<p>software packages</p> <p><b>Becoming an Ubuntu Power User:</b> Administering system and user settings, Learning Unity keyboard shortcuts, Using the Terminal</p> <p><b>Linux Basics:</b> Starting the shell, Shell prompt, Command structure, File Systems and Directory Structure, man pages, more documentation pages</p> <p><b>File System Commands:</b> touch, help, man, more, less, pwd, cd, mkdir, rmdir, ls, find, etc.</p> <p><b>File Handling Commands:</b> cat, cp, rm, mv, more, file, wc, od, cmp, diff, comm, gzip, gunzip, zip, unzip, tar, ln, umask, etc.</p> <p><b>General Purpose Utility Commands:</b> cal, date, echo, man, printf, passwd, script, who, uname, tty, stty, etc.</p> <p><b>Linux File Permissions:</b> Understanding Linux file permissions, Using Linux groups. Decoding file permissions, Changing security settings, chmod, chown, chgrp</p> <hr/> <p><b>Module (30 hours):</b></p> <p><b>Linux Security:</b> Understanding Linux Security, Uses of root, sudo command, Working with passwords, Understanding ssh</p> <p><b>Networking Commands:</b> who, whoami, ping, telnet, ftp, ssh, etc.</p> <p><b>Editors:</b> vi, sed, awk</p> <p><b>Simple Filters and I/O Redirection:</b> head, tail, cut, paste, sort, grep family, tee, uniq, tr, etc.</p> <p><b>Shell Scripting:</b> Defining variables, reading user input, exit and exit status commands, expr, test, [], if conditional, logical operators, Conditions (for loop, until loop, and while loop), arithmetic operations, Redirecting input/output in scripts, creating your own redirection.</p> <p><b>Working and Managing Processes:</b> sh, ps, kill, nice, at, batch, etc.</p> <p><b>Job scheduling commands:</b> ps, nice, renice, at, batch, cron table</p> <p>Installation of C/C++/Java/Python Compiler and Environment Setup and Basic programming using C and Python languages.</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Linux Command line and Shell Scripting Bible, Richard Blum, Wiley India.</li> <li>2. Unix: Concepts and Applications, Sumitabha Das, 4th Edition, McGraw Hill.</li> <li>3. Official Ubuntu Book, Matthew Helmke&amp; Elizabeth K. Joseph with Jose Antonio Rey and Philips Ballew, 8th Ed.</li> </ol>
<p><b>11</b></p>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Linux Administration: A Beginner's Guide, Fifth Edition, Wale Soyinka, Tata McGraw-Hill, 2008.</li> <li>2. Linux: Complete Reference, Richard Petersen, 6th Edition, Tata McGraw-Hill</li> <li>3. Beginning Linux Programming, Neil Mathew, 4th Edition, Wiley Publishing, 2008.</li> </ol>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	<p>The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks.</p> <hr/> <p><b>Total: 20 marks</b></p>	<p>A <b>Semester End Practical Examination</b> of <b>2 hours duration</b> for <b>30 marks</b> as per the paper pattern given below.</p> <p><b>Certified Journal</b> is <b>compulsory</b> for appearing at the time of Practical Exam</p> <hr/> <p><b>Total: 30 Marks</b></p>												
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<b>Q. 3</b>	Viva	06												

**Sem – II**

## Mandatory Courses

### Name of the Course: Design and Analysis of Algorithms

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Design and Analysis of Algorithms course is a fundamental exploration into the systematic study of algorithms, their design principles, and the analysis of their efficiency. It forms the backbone of computer science education, providing essential skills for solving complex computational problems.</p> <p><b>Relevance:</b></p> <p>In the ever-evolving landscape of computer science, the Design and Analysis of Algorithms course is highly relevant. It equips students with the intellectual tools necessary to address challenges in diverse areas, from software development to artificial intelligence.</p> <p><b>Usefulness:</b></p> <p>This course is instrumental in cultivating algorithmic thinking. Participants learn to devise efficient algorithms, analyze their correctness, and evaluate their performance, essential skills for creating optimized solutions in various computing applications.</p> <p><b>Application:</b></p> <p>The knowledge gained from this course finds application in a myriad of scenarios, from developing efficient search and sorting algorithms to optimizing resource utilization in network design and artificial intelligence.</p> <p><b>Interest:</b></p> <p>The course often captivates students due to its intellectual challenges and problem-solving nature. Participants engage in dissecting complex problems, devising algorithmic solutions, and analyzing their efficiency, fostering a deep appreciation for algorithmic thinking.</p> <p><b>Connection with Other Courses:</b></p> <p>The Design and Analysis of Algorithms course establishes vital connections with other computer science disciplines. It forms the basis for advanced courses in data structures, algorithmic complexity, and computational theory, providing a holistic understanding of computation.</p>

		<p><b>Demand in the Industry:</b></p> <p>Professionals well-versed in algorithm design and analysis are in high demand. Industries ranging from technology and finance to healthcare actively seek individuals who can develop efficient algorithms to solve complex problems and enhance system performance.</p> <p><b>Job Prospects:</b></p> <p>Graduates from a Design and Analysis of Algorithms course find themselves well-positioned for various roles, including software engineer, algorithm developer, data scientist, and research scientist. These professionals are valued for their ability to devise elegant and efficient solutions to computational challenges.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives(CO):</b>	<p><b>CO 1.</b> To make students understand the basic principles of algorithm design</p> <p><b>CO 2.</b> To give idea to students about the theoretical background of the basic data structures</p> <p><b>CO 3.</b> To familiarize the students with fundamental problem-solving strategies like searching, sorting, selection, and recursion and help them to evaluate efficiencies of various algorithms.</p> <p><b>CO 4.</b> To teach students the important algorithm design paradigms and how they can be used to solve various real world problems</p>
8	<b>Course Outcomes (OC):</b>	<p><b>OC 1.</b> Students should be able to understand and evaluate efficiency of the programs that they write based on performance of the algorithms used.</p> <p><b>OC 2.</b> Students should be able to appreciate the use of various data structures as per need</p> <p><b>OC 3.</b> To select, decide and apply appropriate design principle by understanding the requirements of any real life problems.</p>
9	<b>Modules:-</b>	
	<b>Module 1 (15 hours):</b>	
		<b>Introduction to algorithms</b> - What is algorithm, analysis of algorithm, Types of complexity, Running time analysis, How to Compare Algorithms, Rate of Growth, Types of Analysis, Asymptotic Notation, Big-O Notation, Omega-Ω Notation, Theta-Θ Notation, Asymptotic Analysis, Performance characteristics of algorithms,

	<p>Estimating running time / number of steps of executions on paper, Idea of Computability</p> <p><b>Introduction to Data Structures</b> - What is data structure, types, Introduction to Array(1-d &amp; 2-d), Stack and List data structures, operations on these data structures, advantages disadvantages and applications of these data structures like solving linear equations, Polynomial Representation, Infix-to-Postfix conversion.</p> <p><b>Recursion</b> - What is recursion, Recursion vs Iteration, recursion applications like Factorial of a number, Fibonacci series &amp; their comparative analysis with respect to iterative version, Tower of Hanoi problem.</p> <p><b>Basic Sorting Techniques</b> - Bubble, Selection and Insertion Sort &amp; their comparative analysis</p> <hr/> <p><b>Module 2 (15 hours):</b></p> <p><b>Searching Techniques</b> - Linear Search and its types, Binary Search and their comparative analysis, Selection Techniques - Selection by Sorting, Partition-based Selection Algorithm, Finding the Kth Smallest Elements in Sorted Order &amp; their comparative analysis, String Algorithms - Pattern matching in strings, Brute Force Method &amp; their comparative analysis</p> <p><b>Algorithm Design Techniques</b> - Introduction to various types of classifications/design criteria and design techniques, Greedy Technique - Concept, Advantages &amp; Disadvantages, Applications, Implementation using problems like - file merging problem. Divide-n-Conquer - Concept, Advantages &amp; Disadvantages, Applications, Implementation using problems like - merge sort, Strassen's Matrix Multiplication</p> <p><b>Dynamic Programming</b> - Concept, Advantages &amp; Disadvantages, Applications, Implementation using problems like - Fibonacci series, Factorial of a number, Longest Common subsequence</p> <p><b>Backtracking Programming</b> - Concept, Advantages &amp; Disadvantages, Applications, Implementation using problems like N-Queen Problem</p>
10	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Data Structure and Algorithm Using Python, Rance D. Ncaise, Wiley India Edition, 2016.</li> <li>2. Data Structures and Algorithms Made Easy, Narasimha Karumanchi, CareerMonk Publications, 2016.</li> <li>3. Introduction to Algorithms, Thomas H. Cormen, 3rd Edition, PHI.</li> </ol>
11	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Pearson, 3rd Edition, 2011.</li> <li>2. Design and Analysis of Algorithms, S. Sridhar, Oxford University Press, 2014.</li> </ol>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>																
<b>13</b>	<b>Continuous Evaluation through:</b> Class Test on Module 1: 10 marks Class Test on Module 2: 10 marks <hr/> <b>Average of 2 Class Tests: 10 marks</b> Assignment on Module 1: 5 marks Assignment on Module 2: 5 marks <hr/> <b>Total of 2 Assignments: 10 marks</b> <b>Total: 20 marks</b>	<b>Evaluation through:</b> A <b>Semester End Theory Examination of 1 hour duration</b> for <b>30 marks</b> as per the paper pattern given below. <hr/> <b>Total: 30 marks</b>																
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## Name of the Course: Introduction to OOP using C++

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	<p><b>Introduction:</b></p> <p>The Introduction to Object-Oriented Programming (OOP) using C++ course is a foundational exploration into the principles of object-oriented programming, using the C++ programming language. This course serves as a gateway for students to understand and apply key concepts in software design and development.</p> <p><b>Relevance:</b></p> <p>In the contemporary software development landscape, understanding OOP principles is crucial. The C++ language, with its strong support for object-oriented features, is widely used in building robust and efficient software systems. This course is, therefore, highly relevant to the needs of modern programming.</p> <p><b>Usefulness:</b></p> <p>The course is instrumental in imparting essential programming paradigms such as encapsulation, inheritance, and polymorphism. Participants gain valuable skills in designing modular and reusable code, contributing to the creation of scalable and maintainable software solutions.</p> <p><b>Application:</b></p> <p>The concepts learned in this course find direct application in software development. Participants learn to structure code using classes and objects, facilitating the creation of efficient and well-organized programs.</p> <p><b>Interest:</b></p> <p>The course often captivates students due to its practical and creative aspects. Through hands-on projects, participants engage in designing and implementing solutions using OOP principles, fostering a deep interest in software design and development.</p> <p><b>Connection with Other Courses:</b></p> <p>This course establishes strong connections with other programming and software engineering courses. It lays the groundwork for advanced studies in software architecture, design patterns, and application development, providing a seamless transition to more</p>

		<p>complex programming concepts.</p> <p><b>Demand in the Industry:</b></p> <p>Professionals with a solid understanding of OOP using C++ are in high demand. Industries ranging from software development to embedded systems actively seek individuals who can leverage OOP principles to create efficient, modular, and maintainable code.</p> <p><b>Job Prospects:</b></p> <p>Students completing this course may find diverse job prospects. Roles may include software developer, systems analyst, application architect, and embedded systems engineer. These professionals are valued for their ability to contribute to the creation of robust and scalable software solutions.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Theory
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To make learner understand the concepts of OOP</p> <p><b>CO 2.</b> To make learner understand the design of OOP through UML</p> <p><b>CO 3.</b> To make learner familiar with the syntax of C++</p> <p><b>CO 4.</b> To make learner Analyze and implement concepts of OOP</p> <p><b>CO 5.</b> To make learner create programs relating to OOP concepts</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> The learner will be able to understand, remember, demonstrate, explain and describe concept of OOP</p> <p><b>OC 2.</b> The learner will be able to design UML based diagrams</p> <p><b>OC 3.</b> The learner will be able to illustrate the different types of control statements in C++</p> <p><b>OC 4.</b> The learner will be able to analyze and implement concept of OOP</p> <p><b>OC 5.</b> The learner will be able to write and create programs relating to OOP concepts</p>	
9	<p><b>Modules:-</b></p> <p><b>Module 1 (15 hours):</b></p> <p><b>Introduction to Programming Concepts:</b> Object oriented programming paradigm, basic concepts of object oriented programming, benefits of object oriented programming, object oriented languages, applications of object oriented programming. Tokens-keywords, identifiers, constants-integer, real, character and string constants, backslash constants, features of C++ and its basic structure, simple</p>	

	<p>C++ program without class, compiling and running C++ program.</p> <p><b>Data Types, Data Input Output and Operators:</b> Basic data types, variables, rules for naming variables, programming constants, the type cast operator, implicit and explicit type casting, cout and cin statements, operators, precedence of operators.</p> <p><b>Decision Making, Loops, Arrays and Strings:</b> Conditional statements-if,if...else, switch loops- while, do...while, for, types of arrays and string and string manipulations</p> <p><b>Unified Modeling Language (UML):</b> Introduction to UML &amp; class diagrams.</p> <p><b>Classes, Abstraction &amp; Encapsulation:</b> Classes and objects, Dot Operator, data members, member functions, passing data to functions, scope and visibility of variables in function.</p> <p><b>Constructors and Destructors:</b> Default constructor, parameterized constructor, copy constructor, private constructor, destructors.</p> <p><b>Working with objects:</b> Accessor - mutator methods, static data and static function, access specifiers, array of objects.</p>
	<p><b>Module 2 (15 hours):</b></p> <p><b>Polymorphism -</b> Binding-static binding &amp; overloading, constructor overloading function overloading, operator overloading, overloading unary and binary operators.</p> <p><b>Modelling Relationships in Class Diagrams:</b> Association, Aggregation-Composition and examples covering these principles</p> <p><b>Inheritance:</b> Defining base class and its derived class, access specifiers, types of inheritance-single, multiple, hierarchical, multilevel, hybrid inheritance, friend function and friend class, constructors in derived classes.</p> <p><b>Modelling Relationships:</b> Generalization-Specialization and examples covering these principles</p> <p><b>Run time Polymorphism -</b> Dynamic Binding, Function overriding, virtual function, pure virtual function, virtual base class, abstract class.</p> <p><b>Pointers:</b> Introduction to pointers, * and &amp; operators, assigning addresses to pointer variables, accessing values using pointers, pointers to objects &amp; this pointer, pointers to derived classes</p> <p><b>File Handling:</b> File Stream classes, opening and closing file-file opening modes, text file handling, binary file handling.</p> <p><b>Applying OOP to solve real life applications:</b> To cover case studies like library management, order management etc. to design classes covering all relationships</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Object Oriented Programming with C++, Balagurusamy E., 8th Edition, McGraw Hill Education India.</li> <li>2. UML &amp; C++: A Practical Guide to Object Oriented Development, Lee/Tepfenhart, Pearson Education, 2nd Edition 2015</li> </ol>

<b>11</b>	<b>Reference Books</b> 1. Mastering C++ by Venugopal, Publisher: McGraw-Hill Education, 2017 2. Let Us C++ by KanetkarYashwant, Publisher: BPB Publications, 2020 3. Object Oriented Analysis and Design by Timothy Budd TMH, 2001																		
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## Name of the Course: Computer Science Practical 2

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b> The Computer Science Practical Course covering Design and Analysis of Algorithms and Object-Oriented Programming (OOP) using C++ is a comprehensive exploration into fundamental computer science concepts and practical programming skills. It integrates the study of algorithmic design with hands-on application using the C++ programming language.</p> <p><b>Relevance:</b> In the dynamic field of computer science, the integration of algorithmic design and object-oriented programming is highly relevant. This course equips students with essential skills to solve complex problems, design efficient algorithms, and implement practical solutions using the OOP paradigm in C++.</p> <p><b>Usefulness:</b> The course is invaluable for developing a strong foundation in algorithmic thinking and software design. Students learn to analyze algorithm efficiency, apply OOP principles for code modularity, and create robust software solutions, enhancing their overall programming proficiency.</p> <p><b>Application:</b> The concepts acquired in this practical course find direct application in real-world scenarios. Students engage in hands-on projects where they design and implement algorithms, analyze their performance, and develop software applications using object-oriented principles in C++.</p> <p><b>Interest:</b> The practical nature of the course often captivates students. Through project-based learning, participants apply algorithmic strategies, design class hierarchies, and implement solutions in C++, fostering a deep interest in problem-solving and software development.</p> <p><b>Connection with Other Courses:</b> This practical course establishes a strong connection with other computer science courses. It lays the groundwork for advanced studies in algorithmic complexity, data structures, software engineering, and advanced topics in object-oriented programming, providing a well-rounded education.</p>

		<p><b>Demand in the Industry:</b> Professionals with proficiency in algorithmic design and object-oriented programming in C++ are in high demand. Industries spanning software development, technology, and finance actively seek individuals who can apply these skills to create efficient and scalable software solutions.</p> <p><b>Job Prospects:</b> Graduates from this practical course have diverse job prospects. Roles may include software engineer, algorithm developer, systems analyst, or application developer. These professionals are valued for their ability to contribute to algorithmically optimized, modular, and maintainable software.</p>
2	<b>Vertical:</b>	Major
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b>  <b>CO 1.</b> Analyze and implement algorithms for common computational problems.  <b>CO 2.</b> Implement algorithms using divide and conquer strategies.  <b>CO 3.</b> Apply dynamic programming techniques to solve optimization problems.  <b>CO 4.</b> Implement and analyze algorithms based on greedy strategies.  <b>CO 5.</b> Comprehend the principles of object-oriented programming.  <b>CO 6.</b> Design and implement classes and objects in C++.  <b>CO 7.</b> Implement single, multiple, and hierarchical inheritance.  <b>CO 8.</b> Implement operator overloading for user-defined types.  <b>CO 9.</b> Understand the impact of access specifiers on class members.</p>	
8	<p><b>Course Outcomes (OC):</b>  <b>OC 1.</b> Design and implement algorithms for various problem domains.  <b>OC 2.</b> Evaluate and compare the time and space complexities of algorithms.  <b>OC 3.</b> Apply divide and conquer strategies to solve computational problems.  <b>OC 4.</b> Utilize dynamic programming techniques for optimization problems.  <b>OC 5.</b> Implement and analyze algorithms based on greedy strategies.  <b>OC 6.</b> Design and implement classes and objects in C++.  <b>OC 7.</b> Apply inheritance and polymorphism concepts in program development.  <b>OC 8.</b> Implement operator overloading for enhanced class functionality.  <b>OC 9.</b> Utilize advanced features like friend functions, inline functions, and this pointer.  <b>OC 10.</b> Understand the impact of scope specifiers on class members.</p>	

9

**Modules:-**

**Module 1 (30 hours):**

**Design & Analysis of Algorithms – Practical**

**Array Operations:**

Implement programs for 1-d arrays, Implement programs for 2-d arrays.

**List-Based Stack Operations:**

Create a list-based stack and perform stack operations.

**Linear and Binary Search:**

Implement linear and binary search algorithms on a list.

**Sorting Algorithms:**

Implement sorting algorithms (e.g., bubble, selection, insertion).

**Nth Max/Min Element:**

Implement algorithms to find Nth Max/Min element in a list.

**String Pattern Matching:**

Implement algorithms to find a pattern in a given string.

**Recursion:**

Implement recursive algorithms (e.g., factorial, Fibonacci, Tower of Hanoi).

**Greedy Algorithm:**

Solve problems like file merging and coin change using the Greedy Algorithm.

**Divide and Conquer:**

Implement algorithms like merge sort and Strassen's Matrix Multiplication.

**Dynamic Programming:**

Implement algorithms for Fibonacci series and Longest Common Subsequence using dynamic programming.

**Module 2 (30 hours):**

**OOPs using C++ – Practical**

**Introduction to Classes:**

Create a simple class with data members and member functions.

Demonstrate the use of class instances to access data and invoke member functions.

**Branching and Looping with Classes:**

Implement programs utilizing branching and looping statements within class methods.

**Arrays and Classes:**

	<p>Develop a program that employs one and two-dimensional arrays within a class. Illustrate how classes can handle array-based data structures.</p> <p><b>Scope Resolution Operator:</b></p> <p>Use the scope resolution operator to declare variables at different scope levels. Display and compare the values of variables with different scopes.</p> <p><b>Constructors and Destructors:</b></p> <p>Implement programs showcasing various types of constructors and destructors. Explore default, parameterized, copy constructors, and destructor functionalities.</p> <p><b>Access Specifiers:</b></p> <p>Demonstrate the use of public, protected, and private scope specifiers within a class. Understand the impact of different access specifiers on class members.</p> <p><b>Inheritance:</b></p> <p>Implement classes to demonstrate single and multilevel inheritance scenarios. Showcase how derived classes inherit properties from the base class. Develop programs illustrating multiple and hierarchical inheritance. Create programs that demonstrate the interaction between inheritance and derived class constructors. Understand the order of constructor invocation in the inheritance hierarchy.</p> <p><b>Advanced Concepts:</b></p> <p>Implement programs showcasing friend functions, inline functions, and the use of the this pointer within classes.</p> <p><b>Function Overloading and Overriding:</b></p> <p>Develop programs to demonstrate function overloading and overriding within classes.</p> <p><b>Pointers and File Handling:</b></p> <p>Explore the use of pointers within classes, emphasizing dynamic memory allocation. Develop programs for both text and binary file handling within a class context.</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Data Structure and Algorithm Using Python, Rance D. Necaie, Wiley India Edition, 2016.</li> <li>2. Object Oriented Programming with C++, Balagurusamy E., 8th Edition, McGraw Hill Education India.</li> </ol>

<b>11</b>	<b>Reference Books</b> 1. Data Structures and Algorithms Made Easy, Narasimha Karumanchi, CareerMonk Publications, 2016. 2. Let Us C++ by Kanetkar Yashwant, Publisher: BPB Publications, 2020																
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## Vocational & Skill Enhancement Courses (VSEC)

### Name of the Course: Web Designing

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Web Designing Course is an immersive exploration into the core technologies that drive the visual and interactive aspects of the web. Covering HTML, CSS, Javascript, XML, and PHP, this course equips individuals with the skills needed to create dynamic and aesthetically pleasing websites.</p> <p><b>Relevance:</b></p> <p>In the digital age, web design is paramount. The course remains highly relevant as it introduces participants to the fundamental languages and technologies that form the backbone of modern web development.</p> <p><b>Usefulness:</b></p> <p>The course is invaluable for anyone interested in creating responsive, user-friendly, and visually appealing websites. Participants gain practical skills in structuring web content, styling layouts, and implementing interactive features.</p> <p><b>Application:</b></p> <p>The concepts learned in this course find direct application in real-world web development projects. Participants design and build websites, applying HTML for structure, CSS for styling, Javascript for interactivity, XML for data representation, and PHP for server-side scripting.</p> <p><b>Interest:</b></p> <p>The creative and hands-on nature of web design often captivates students. Through practical exercises, participants engage in designing and developing websites, fostering a deep interest in creating visually engaging online experiences.</p> <p><b>Connection with Other Courses:</b></p> <p>This course establishes strong connections with various other courses in the field of web development and computer science. It provides a foundation for advanced studies in full-stack development, database management, and server-side scripting.</p>

		<p><b>Demand in the Industry:</b></p> <p>Professionals with strong web designing skills are in high demand. Industries spanning e-commerce, technology, and media actively seek individuals who can create user-friendly and visually appealing websites to enhance online presence and user engagement.</p> <p><b>Job Prospects:</b></p> <p>Graduates from a Web Designing Course find diverse job prospects. Roles may include web designer, front-end developer, UI/UX designer, and web content manager. These professionals are sought after for their ability to create visually stunning and functional web interfaces.</p>
2	<b>Vertical:</b>	VSC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To understand the concept of Web Technologies</p> <p><b>CO 2.</b> To understand the concepts of Hyper Text Markup Language and Cascading Style Sheets.</p> <p><b>CO 3.</b> To learn JavaScript for creating dynamic websites.</p> <p><b>CO 4.</b> To learn various operations performed on data among web applications using XML</p> <p><b>CO 5.</b> To learn Server-Side Programming using PHP</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Design valid, well-formed, scalable, and meaningful pages using emerging technologies.</p> <p><b>OC 2.</b> Understand the various platforms, devices, display resolutions, viewports, and browsers that render websites</p> <p><b>OC 3.</b> Develop and implement client-side and server-side scripting language programs.</p> <p><b>OC 4.</b> Develop and implement Database Driven Websites.</p> <p><b>OC 5.</b> Design and apply XML to create a markup language for data and document centric applications.</p>	
9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>HTML:</b> Fundamental Elements of HTML, Formatting Text in HTML, Organizing Text in HTML, List Tags, Links and URLs in HTML, Tables in HTML, Images on a Web Page, Image Formats, Image Maps, Colors, Navigation across multiple pages, Forms in HTML, Interactive Elements, Working with Multimedia - Audio and Video</p>	

	<p>File Formats, HTML elements for inserting Audio / Video on a web page</p> <p><b>CSS:</b> Understanding the Syntax of CSS, CSS Selectors, Inserting CSS in an HTML Document, CSS properties to work with background of a Page, CSS properties to work with Fonts and Text Styles, CSS properties for positioning an element.</p> <p><b>JavaScript:</b> Using JavaScript in an HTML Document, Programming, Fundamentals of JavaScript – Variables, Operators, Control Flow Statements, Popup Boxes, Functions – Defining and Invoking a Function, Defining Function arguments, defining a return Statement, Calling Functions with Timer, JavaScript Objects - String, RegExp, Math, Date, Browser Objects - Window, Navigator, History, Location, Document, Cookies, Document Object Model, Form Validation using JavaScript</p>	
	<b>Module 2 (30 hours):</b>	
	<p><b>XML:</b> Comparing XML with HTML, Advantages and Disadvantages of XML, Structure of an XML Document, XML Entity References, with Internal / External DTD, XSLT Elements and Attributes</p> <p><b>AJAX:</b> AJAX Web Application Model, How AJAX Works, XMLHttpRequest Object – Properties and Methods, Handling asynchronous requests using AJAX e.g. Mouseover, button click,</p> <p><b>PHP:</b> Variables and Operators, Retrieving data from HTML forms, Program Flow, Arrays, working with Files and Directories, working with Databases, Working with Cookies, Sessions, and Headers</p>	
<b>10</b>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and jQuery, 2ed, Dreamtech Press, 2016</li> <li>2. Web Programming and Interactive Technologies, scriptDemics, StarEdu Solutions India, 2018</li> <li>3. PHP: A Beginners Guide, Vikram Vaswani, TMH</li> </ol>	
<b>11</b>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. HTML, XHTML, and CSS Bible Fifth Edition, Steven M. Schafer, WILEY, 2011</li> <li>2. Learning PHP, MySQL, JavaScript, CSS &amp; HTML5, Robin Nixon, O'Reilly, 2018</li> <li>3. PHP, MySQL, JavaScript &amp; HTML5 All-in-one for Dummies, Steve Suehring, Janet Valade Wiley, 2018</li> </ol>	
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>
<b>13</b>	<p>The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks.</p>	<p><b>A Semester End Practical Examination of 2 hours duration for 30 marks</b> as per the paper pattern given below.</p> <p><b>Certified Journal is compulsory</b> for appearing at the time of Practical Exam</p>

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## Name of the Course: Database Management Systems Using PL/SQL

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Database Management Systems (DBMS) Using PL/SQL course is a comprehensive exploration into the principles and practices of managing databases using the powerful PL/SQL language. This course provides participants with the skills needed to design, implement, and maintain robust database systems.</p> <p><b>Relevance:</b></p> <p>In the era of information technology, databases serve as the backbone of applications. The course is highly relevant as it delves into PL/SQL, a procedural language designed for seamless interaction with Oracle databases, one of the most widely used database management systems.</p> <p><b>Usefulness:</b></p> <p>The course is invaluable for individuals seeking proficiency in database management. Participants learn to harness the capabilities of PL/SQL for efficient data storage, retrieval, and manipulation, enhancing the functionality and performance of database systems.</p> <p><b>Application:</b></p> <p>The concepts learned in this course find direct application in real-world scenarios. Participants design and implement database structures, write PL/SQL scripts for data manipulation, and optimize database performance, ensuring the efficient operation of data-centric applications.</p> <p><b>Interest:</b></p> <p>The hands-on and problem-solving nature of working with databases and PL/SQL often captivates students. Through practical exercises, participants engage in creating and managing databases, fostering a deep interest in efficient data storage and retrieval.</p> <p><b>Connection with Other Courses:</b></p> <p>This course establishes strong connections with other courses in the field of database management, data analytics, and software development. It provides a foundation for advanced studies in database optimization,</p>

		<p>data warehousing, and application development.</p> <p><b>Demand in the Industry:</b></p> <p>Professionals proficient in database management using PL/SQL are in high demand. Industries spanning finance, healthcare, and e-commerce actively seek individuals who can design and manage databases to ensure data integrity, security, and optimal performance.</p> <p><b>Job Prospects:</b></p> <p>Graduates from a DBMS Using PL/SQL course find diverse job prospects. Roles may include database administrator, SQL developer, data analyst, and database architect. These professionals are valued for their ability to create and manage databases critical to organizational success.</p>
2	<b>Vertical:</b>	SEC
3	<b>Type:</b>	Practical
4	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted:</b>	60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> To develop understanding of concepts and techniques for data management</p> <p><b>CO 2.</b> To learn about widely used systems for implementation and usage</p> <p><b>CO 3.</b> To develop understanding of Transaction management and crash recovery.</p>	
8	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Master concepts of stored procedure, functions, cursors and triggers and its use.</p> <p><b>OC 2.</b> Learn about using PL/SQL for data management.</p> <p><b>OC 3.</b> Use efficiently Collections and records.</p> <p><b>OC 4.</b> Understand concepts and implementations of transaction management and crash recovery.</p>	
9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>Overview of PL/SQL:</b> Advantages of PL/SQL, Main Features of PL/SQL, Architecture of PL/SQL</p> <p><b>Fundamentals of PL/SQL:</b> Character Sets, Lexical Units, Declarations, References to Identifiers, Scope and Visibility of Identifiers, Assigning Values to Variables, Expressions, Error-Reporting Functions, Data Types., Control Statements: Conditional Selection Statements, LOOP Statements, Sequential Control Statements, GOTO, and NULL Statements.</p>	

	<p><b>Sequences:</b> creating sequences, referencing, altering, and dropping a sequence.</p> <p><b>Stored Procedures and Functions:</b> Procedures: Types and benefits of stored procedures, creating stored procedures, executing stored procedures, altering stored procedures, viewing stored procedures. Functions: Calling function and recursion function.</p> <p><b>Collections and Records:</b> Associative Arrays, Varrays (Variable-Size Arrays), Nested Tables, Collection Constructors, Assigning Values to Collection Variables, Multidimensional Collections, Collection Comparisons, Collection Methods, Collection Types Defined in Package Specifications, Record Variables, Assigning Values to Record Variables.</p> <p><b>Error Handling:</b> Compile-Time Warnings, Overview of Exception Handling, Internally Defined Exceptions, Predefined Exceptions, User- Defined Exceptions, Redeclared Predefined Exceptions, Raising Exceptions Explicitly, Exception Propagation, Unhandled Exceptions.</p> <hr/> <p><b>Module 2 (30 hours):</b></p> <p><b>Cursors:</b> Overview of Cursor, Types of cursors, Invalid cursor Exception.</p> <p><b>Static SQL:</b> Description of Static SQL, Cursors Overview, Processing Query Result Sets, Cursor Variables, CURSOR Expressions,</p> <p><b>Transaction Processing and Control:</b> Autonomous Transactions, Commit Protocol, Concurrency Control, Lock Management, Read-Write Locks, Deadlocks Handling,</p> <p><b>Dynamic SQL:</b> Native Dynamic SQL, DBMS_SQL Package, SQL Injection.</p> <p><b>Triggers:</b> Overview of Triggers, implementing triggers – creating triggers, Insert, delete, and update triggers, nested triggers, viewing, deleting, and modifying triggers, enforcing data integrity through triggers.</p> <p><b>Packages:</b> Overview of a Package. Need of Packages, Package Specification, Package Body, Package Instantiation, and Initialization. Create nested tables and work with nested tables.</p>
<p><b>10</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Mastering PL/SQL Through Illustrations: From Learning Fundamentals to Developing Efficient PL/SQL Blocks, Dr. B. Chandra, BPB Publication, 2020</li> <li>2. Oracle PL/SQL Training Guide., Training guide, BPB Publications, 2016</li> <li>3. Raghu Ramakrishnam, Gehrke, Database Management Systems, McGraw-Hill,3rd Edition, 2014</li> <li>4. Abraham Silberschatz, Henry F. Korth,S. Sudarshan , Database System Concepts, 6th Edition 2019</li> </ol>
<p><b>11</b></p>	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Ivan Bayross, SQL, PL/SQL -The Programming language of Oracle, B.P.B. Publications 2009</li> <li>2. Ramez Elmasri &amp; Shamkant B.Navathe, Fundamentals of Database Systems, Pearson Education, 2008</li> </ol>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks. <hr/> <b>Total: 20 marks</b>	A <b>Semester End Practical Examination</b> of <b>2 hours duration</b> for <b>30 marks</b> as per the paper pattern given below.  <b>Certified Journal</b> is <b>compulsory</b> for appearing at the time of Practical Exam <hr/> <b>Total: 30 Marks</b>												
<b>14</b>	<b>Format of Question Paper:</b>  <b>Total Marks: 30</b> <span style="float: right;"><b>Duration: 2 Hours</b></span>													
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## Name of the Course: Advanced Python Programming

Sr. No.	Heading	Particulars
1	Description the course:	<p><b>Introduction:</b></p> <p>The Advanced Python Programming Course is designed to elevate coding skills to a more sophisticated level, offering participants a deeper understanding of Python's advanced features and capabilities. Building upon the foundations laid in basic Python courses, this advanced course delves into complex programming concepts and techniques.</p> <p><b>Relevance:</b></p> <p>As technology advances, the relevance of Python continues to grow. The Advanced Python Programming Course is a response to the increasing demand for skilled Python developers who can tackle intricate challenges in various domains, including software development, data science, artificial intelligence, and more.</p> <p><b>Usefulness:</b></p> <p>This course goes beyond basic syntax and introduces participants to advanced Python topics such as decorators, generators, metaclasses, and asynchronous programming. Learners gain valuable insights into optimizing code performance, enhancing code readability, and solving complex problems efficiently.</p> <p><b>Application:</b></p> <p>Graduates of this course can apply their advanced Python skills to tackle more complex programming tasks, develop scalable applications, and contribute to large-scale software projects. The course's emphasis on practical applications ensures that participants are well-equipped for real-world programming challenges.</p> <p><b>Interest:</b></p> <p>The course maintains an engaging learning experience, balancing theoretical concepts with hands-on projects that challenge participants to apply their knowledge creatively. This approach fosters a continued interest in Python programming and encourages learners to explore advanced topics with enthusiasm.</p> <p><b>Connection with Other Courses:</b></p> <p>The knowledge gained in the Advanced Python</p>

		<p>Programming Course establishes a strong foundation for further specialization in advanced Python libraries, frameworks, and application domains. This course acts as a bridge to more specialized fields such as machine learning, web development, and data engineering.</p> <p><b>Demand in the Industry:</b></p> <p>Professionals with advanced Python skills are highly sought after in the industry. The ability to leverage Python's advanced features for efficient problem-solving, code optimization, and system architecture places graduates of this course in high demand across diverse sectors.</p> <p><b>Job Prospects:</b></p> <p>Completing the Advanced Python Programming Course opens doors to advanced positions in software development, data engineering, scientific computing, and research. Job prospects include roles such as Python developer, data scientist, machine learning engineer, and backend developer, among others.</p>
<b>2</b>	<b>Vertical:</b>	SEC
<b>3</b>	<b>Type:</b>	Practical
<b>4</b>	<b>Credits:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
<b>5</b>	<b>Hours Allotted:</b>	60 Hours
<b>6</b>	<b>Marks Allotted:</b>	50 Marks
<b>7</b>	<p><b>Course Objectives(CO):</b></p> <p><b>CO 1.</b> Master OOPs principles, solving real-world problems.</p> <p><b>CO 2.</b> Create robust Python classes, transfer members efficiently.</p> <p><b>CO 3.</b> Understand and implement inheritance, utilize advanced polymorphism..</p> <p><b>CO 4.</b> Implement abstract classes, leverage interfaces for flexible code.</p> <p><b>CO 5.</b> Create and synchronize threads, mitigate deadlock issues.</p>	
<b>8</b>	<p><b>Course Outcomes (OC):</b></p> <p><b>OC 1.</b> Demonstrate comprehensive OOPs proficiency, apply principles effectively.</p> <p><b>OC 2.</b> Develop efficient, reusable classes, successfully transfer members.</p> <p><b>OC 3.</b> Ability to implement inheritance and apply advanced polymorphism.</p> <p><b>OC 4.</b> Ability to implement abstract classes, demonstrate flexibility through interfaces.</p> <p><b>OC 5.</b> Ability to thread creation, synchronization, and effective deadlock resolution.</p>	

9	<p><b>Modules:-</b></p> <p><b>Module 1 (30 hours):</b></p> <p><b>OOPs In Python:</b> Introduction to OOPs, Problems in Procedure Oriented Approach, Features of Object Oriented Programming System (OOPS), Constructors and Destructors,</p> <p><b>Classes and Objects-</b> Creating a Class, Self-Variable, Types of Variables, Types of Methods, Passing Members of One Class to Another Class</p> <p><b>Inheritance and Polymorphism:</b> Types of Inheritance, Constructors in Inheritance, Overriding Super Class Constructors and Methods, super() method, Polymorphism, Duck Typing , Operator Overloading, Method Overloading, Method Overriding</p> <p><b>Abstract Classes and Interfaces:</b> Abstract Class, Abstract Method, Interfaces in Python</p> <p><b>Threads in Python:</b> Creating Threads in Python, Single Tasking and Multitasking, Thread Synchronisation, Deadlock in Threads</p> <hr/> <p><b>Module 2 (30 hours):</b></p> <p><b>Working with Databases:</b> DBMS, working with MySQL Database-retrieving, inserting, deleting, updating rows from table, Creating Database Tables through Python</p> <p><b>Exceptions:</b> Errors in a Python Program, Exceptions and Exceptions handling, User Defined Exceptions, Logging Exceptions,</p> <p><b>Networking:</b> TCP/IP Protocol Architecture, , User Datagram Protocol (UDP), FTP Architecture, Web Page Operations, Sending a Simple Mail</p> <p><b>Graphical User Interface:</b> Creating a GUI in Python, Widget classes, Layout Manager, Event Handling</p> <p><b>Data Science Tools:</b> Introduction to NumPy, Matplotlib, pandas, Scipy,</p>
10	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Practical Programming: An Introduction to Computer Science Using Python 3, Paul Gries , Jennifer Campbell, Jason Montojo, Pragmatic Bookshelf, 2nd Edition, 2014</li> <li>2. Programming through Python, M. T Savaliya, R. K. Maurya&amp; G M Magar, Sybgen Learning India, 2020</li> </ol>
11	<p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Python: The Complete Reference, Martin C. Brown, McGraw Hill, 2018</li> <li>2. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress, 2017</li> <li>3. Programming in Python 3, Mark Summerfield, Pearson Education, 2nd Ed, 2018</li> </ol>

<b>12</b>	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>												
<b>13</b>	<p>The internal evaluation will be determined by the completion of practical tasks and the submission of corresponding write-ups for each session. Each practical exercise holds a maximum value of 5 marks. The total evaluation, out of 50 marks, should be scaled down to a final score of 20 marks.</p> <p><b>Total: 20 marks</b></p>	<p><b>A Semester End Practical Examination of 2 hours duration for 30 marks</b> as per the paper pattern given below.</p> <p><b>Certified Journal is compulsory</b> for appearing at the time of Practical Exam</p> <p><b>Total: 30 Marks</b></p>												
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## Letter Grades and Grade Points:

<b>Semester GPA/ Programme CGPA Semester/ Programme</b>	<b>% of Marks</b>	<b>Alpha-Sign/ Letter Grade Result</b>	<b>Grading Point</b>
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	----	Ab (Absent)	0

### Justification for B.Sc. (Computer Science)

1.	Necessity for starting the course:	The B.Sc. (Computer Science) course is strategically designed to meet the rising demand for skilled professionals while emphasizing innovation. In today's tech-driven era, it addresses the need for individuals proficient in computer science principles, programming, and creative problem-solving. This program not only fills the industry demand for qualified graduates but also instills an innovative mindset, preparing students to drive advancements and address real-world challenges.
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	All courses under the B.Sc. (Computer Science) program have commenced as of the academic year 2023-24. Furthermore, the course has been restructured in alignment with the National Education Policy (NEP) 2020, effective from the academic year 2024-2025.
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?	The courses initiated by the University are self-financed, adhering to the sanction provided by the University of Mumbai to affiliated colleges. The availability of an adequate number of eligible permanent faculties aligns with the self-financed nature of these courses.
5.	To give details regarding the duration of the Course and is it possible to compress the course?	The course duration is three years, spanning six semesters. It is not feasible to compress the course, as the curriculum is structured to ensure comprehensive coverage of the required subjects and allow for effective learning and skill development.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	The intake capacity of the course is 60 students per division. The intake capacity varies across affiliated colleges depending upon the sanction received from the University from time to time.

7.	Opportunities of Employability / Employment available after undertaking these courses:	Upon completion of the B.Sc. (Computer Science) course, students will be well-equipped to pursue various opportunities in the dynamic IT industry, with a strong emphasis on innovation. Graduates will possess the skills required for roles in cutting-edge areas such as software development, data analysis, artificial intelligence, cybersecurity, and more. The curriculum is meticulously designed to align with industry needs and foster a spirit of innovation, making graduates not only highly sought after but also well-prepared to contribute to advancements in technology. The course is structured to instill not only theoretical knowledge but also practical skills and a mindset of innovation, ensuring that graduates are highly employable in diverse and evolving roles such as software development, data analysis, and system administration.

**Sign of the BOS Chairman**  
**Dr. Jyotshna Dongardive**  
Ad-hoc BOS (Computer Science)

**Sign of the Offg. Associate Dean**  
**Dr. Madhav R. Rajwade**  
Faculty of Science & Technology

**Sign of Offg. Dean**  
**Prof. Shivram S. Garje**  
Faculty of Science & Technology

AC –20.04.2024  
Item No. –5.6 (N) Sem I (1a)

# As Per NEP 2020

## University of Mumbai



<b>Syllabus for Basket of AEC</b>	
<b>Board of Studies in English</b>	
<b>UG First Year Programme B.Sc</b>	
<b>Semester</b>	<b>I</b>
<b>Title of Paper</b>	<b>Credits</b>
<b>Introduction to Communication Skills in English I</b>	<b>2</b>
<b>From the Academic Year</b>	<b>2024-2025</b>

Sr. No.	Heading	Particulars
1	<b>Description of the course: Including but Not limited to:</b>	<p><b>Introduction to Communication Skills in English I</b></p> <p>Effective academic communication skills are essential for success in scholarly pursuits. In the academic realm, proficiency extends beyond verbal articulation to encompass precise and coherent written expression. Students are not only required to engage in thoughtful discussions and articulate complex ideas verbally but must also demonstrate their understanding through well-crafted written assignments, and presentations. Academic communication involves the mastery of scholarly conventions, such as adherence to academic writing styles, and the ability to engage in dialogue with peers and scholars. It encompasses the skillful navigation of academic discourse, fostering an environment where ideas are shared, challenged, and refined. Developing strong academic communication skills empower individuals to contribute meaningfully to intellectual conversations, enriching both their academic journey and the broader scholarly community.</p> <p>This course with its 30:20 pattern will also help in accomplishing this goal. The course is aimed at honing their cognitive, analytical, linguistic and creative skills. It is hoped that by the end of the academic year, the learners will have developed confidence in using the English language both for oral and written communication as well as develop interest in enhancing these skills later on.</p>
2	<b>Vertical:</b>	AEC (Ability Enhancement Course)
3	<b>Type:</b>	Theory
4	<b>Credit:</b>	2 credits (1credit=15 Hours for Theory in a semester)
5	<b>Hours Allotted:</b>	30Hours
6	<b>Marks Allotted:</b>	50Marks
7	<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To cultivate a comprehensive understanding of communication skills</li> <li>2. To enhance reading proficiency with a diverse range of written texts with different genres and styles of written communication.</li> <li>3. To develop proficiency in grammatical accuracy with specific focus on common grammatical errors and provide targeted exercises for improvement.</li> <li>4. To equip learners with proficient presentation and conversation skills by integrating practical exercises for public speaking and interpersonal communication.</li> <li>5. To provide practical experience in formal writing, including Statement of Purpose (SoP) preparation.</li> </ol>

**8 Course Outcomes:**

At the end of the course, learners will:

- Demonstrate an understanding of essential aspects of communication skills
- Exhibit the ability to Read a variety of written text using subskills such as skimming and scanning.
- Identify and rectify common grammatical errors in English.
- Show competence in delivering compelling presentations and engage in articulate and effective conversations in English across different contexts.
- Display advanced formal writing skills in crafting job application letters, CVs, and Statements of Purpose.

**9 Modules: -**

**Module1: (15 Lectures)**

**A) Introduction to Communication Skills**

- The Seven Cs of Effective Communication
- Verbal and Non-Verbal Communication
- Cross-cultural communication
- Technology-enabled Business Communication
- Features of Effective Written Communication
- Characteristics of an Effective Speech
- Effective Listening Skills

**B) Reading Skills:**

- Scanning a text for information
  - Skimming a passage to look for main ideas, understanding text type
  - Guessing meaning of an expression (word/phrase/clause)
  - Building inference skills
- Passages from academic, professional, and literary domains around 200- 250 words, could be chosen in this section.

**C) Grammar**

- Subject Verb Agreement
- Tenses
- Question Tag
- Change the Voice
- Framing Interrogative sentence
- Synonyms and Antonyms
- Misplaced modifiers

Grammar should be taught with a remedial approach so as to enable learners to avoid common errors in their written and spoken communication.

**Module 2: (15 Lectures)**

**A) Speaking Skills in English**

**Conversation skills**

- Opening a conversation
- Introducing oneself in various contexts
- Introducing others formally and informally

**Presentation Skills**

- Introduction: Essentials of Presentation skills
- Analysis of model Presentations
- Planning and Delivering the Presentation
- Developing & Displaying Visual Aids
- Handling Questions from the Audience

**B) Formal Writing Skills:**

- Interpreting and describing different types of visual information
- Job applications with bio data (solicited and unsolicited)
- Statement of Purpose

**10 Text Books: N.A.**

**11 References:**

- Bellare, Nirmala. *Reading & Study Strategies*. Books. 1 and 2. Oxford University Press, 1997, 1998
- Bellare, Nirmala. *Easy Steps to Summary Writing and Note-Making*. Amazon Kindle Edition, 2020
- Comfort, Jeremy, et al. *Speaking Effectively: Developing Speaking Skills for Business English*. Cambridge University Press, 1994.
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- Doff, Adrian and Christopher Jones. *Language in Use* (Intermediate and Upper Intermediate). CUP, 2004.
- Glendinning, Eric H. and Beverley Holmstrom. Second edition. *Study Reading: A Course in Reading Skills for Academic Purposes*. CUP, 2004
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- Murphy, Raymond, et al. *Grammar in use: Intermediate*. Cambridge University Press, 2000
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- Sasikumar, V., et al. *A Course in Listening & Speaking I*. 2005. Cambridge University Press India Pvt. Ltd. (under the Foundation Books Imprint), 2010
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- Sethi, J. *Standard English and Indian usage: Vocabulary and grammar*. PHI Learning Pvt. Ltd., 2011.
- Taylor, Grant. *English Conversation Practice*. 1967. Tata McGraw-Hill, 2013
- Turton, Nigel D. *A B C of Common Grammatical Errors*. 1995. Macmillan India Ltd., 1996
- Vas, Gratian. *English Grammar for Everyone*. Mumbai, Shree Book Centre, 2015
- Watson, T. *Reading Comprehension Skills and Strategies: Level 6*. Saddleback Educational Publishing, 2002

#### Web link Resources:

- A conversation about household appliances: <https://youtu.be/rAPI0fSborU> 13.
- Video on psychology: Why do we dream? <https://youtu.be/2W85Dwxx218>
- Video on social media: What is a social media influencer? <https://youtu.be/39A3og7enz8>
- Tips on communication (TED Talk): The Secrets of Learning a New Language [https://youtu.be/o\\_XVt5rdpFY](https://youtu.be/o_XVt5rdpFY)
- Expressing opinions: If Cinderella Were a Guy: <https://youtu.be/p40yCNctKXg>
- Video on the English language: Where did English come from? <https://youtu.be/YEaSxhcns7Y>

12	<b>Internal Continuous Assessment: 40%</b>	<b>Semester End Examination: 60%</b>								
13	<p><b>Continuous Evaluation through:</b></p> <ul style="list-style-type: none"> <li>• Participation in an activity based on Presentation Skills and Conversation skills each (Module 2 A) (10 marks) The class may be divided into batches by creating formal schedule for the same before the semester End Examination.</li> <li>• Participation in two classroom activities involving skills other than presentation and conversation skills (05 marks)</li> <li>• Overall attendance (05 marks) (Percentage of learners' attendance in class to be considered)</li> </ul> <p><b>Suggested Activities:</b></p> <ul style="list-style-type: none"> <li>▪ Listening to audio clips/ books to enhance listening skills</li> <li>▪ Reading aloud from newspapers, magazines, stories, non-fiction followed by classroom discussion on these to enhance reading and speaking skills</li> </ul>									
14	<p><b>Format of Question Paper:</b> for the final examination</p> <table border="0" style="width: 100%;"> <tr> <td>Q.1. Short notes (2 out of 4) – On Module 1 (A)</td> <td style="text-align: right;">10 marks</td> </tr> <tr> <td>Q.2. A. Unseen Passage (200-250 words) (Module 1 B)</td> <td style="text-align: right;">06 marks</td> </tr> <tr> <td>      B. Questions on grammar (Module 1 C)</td> <td style="text-align: right;">04 marks</td> </tr> <tr> <td>Q. 3. Writing Skills (1 out of 2) on Module 2 (B)</td> <td style="text-align: right;">10 marks</td> </tr> </table>		Q.1. Short notes (2 out of 4) – On Module 1 (A)	10 marks	Q.2. A. Unseen Passage (200-250 words) (Module 1 B)	06 marks	B. Questions on grammar (Module 1 C)	04 marks	Q. 3. Writing Skills (1 out of 2) on Module 2 (B)	10 marks
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Q.2. A. Unseen Passage (200-250 words) (Module 1 B)	06 marks									
B. Questions on grammar (Module 1 C)	04 marks									
Q. 3. Writing Skills (1 out of 2) on Module 2 (B)	10 marks									

**Sign of BOS Chairman  
Prof. Dr. Shivaji Sargar  
Board of Studies in  
English**

**Sign of the Offg.  
Associate Dean  
Dr. Suchitra Naik  
Faculty of  
Humanities**

**Sign of the Offg.  
Associate Dean  
Dr. Manisha Karne  
Faculty of  
Humanities**

**Sign of the Dean  
Prof. Dr. Anil Singh  
Faculty of  
Humanities**

AC – 20/04/2024  
Item No. – 6.6 Sem. I (7a)

## As Per NEP 2020

# University of Mumbai



<b>Syllabus for Basket of OE</b>	
<b>Board of Studies in Statistics</b>	
<b>UG First Year Programme</b>	
<b>Semester - I</b>	
<b>Title of Paper</b>	<b>Credits 2</b>
<b>I) Introduction to Basic Statistics-I</b>	<b>2 credit</b>
<b>II)</b>	
<b>III)</b>	
<b>From the Academic Year</b>	<b>2024-25</b>

**Semester-I**  
**Open Electives-I**  
**Name of the course: Introduction to Basic Statistics-I**

<b>Sr. No</b>	<b>Heading</b>	<b>Particulars</b>
1	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<p>Introduction:</p> <p>Introduction to Basic statistics-I course is focuses on basic statistics such as collection of data and how to measure variables on different scale. Student will equip with to identify the scale of measurement and analyze elementary statistical analysis through graphical presentation. Also student will learn to identify nature of the data through statistical methods. This course mainly emphasizes the method of collecting data, summarizing and presenting data, and drawing inferences from the data.</p> <p>This course will be useful for science, humanity and commerce faculty. This course will be offered other than science faculty students which will be very useful to gain knowledge about basic statistics in their field. This course will be applicable to various field to analyze their basic data structure.</p> <p>This course is focuses practical as well as theoretical aspects of basic statistics along with subjects from psychology, Economics, sociology, commerce, Computers , Mathematics , IT etc.</p> <p>There is growing demand for highly skilled statisticians in the 21st century in many fields including government, banking sector, health sciences, veterinary sciences, agricultural sciences, business, and social sciences etc</p>
2	<b>Vertical :</b>	Open Elective
3	<b>Type :</b>	Theory
4	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )

5	<b>Hours Allotted :</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives:</b> Students will be able to, <ol style="list-style-type: none"> <li>1. Understand the meaning of Statistics and scope of Statistics.</li> <li>2. Understand techniques of data collection and its presentation.</li> <li>3. Compute various measures of central tendencies to know the entire data by a centralized single value.</li> <li>4. Understand spread and variation of data using various techniques of measure of dispersion.</li> <li>5. Understand the behavior of data using skewness and kurtosis and study the nature of probability curve.</li> </ol>	
8	<b>Course Outcomes:</b> <b>: on successful completion of the course Students Should be able to,</b> <ol style="list-style-type: none"> <li>1. Calculate arithmetic mean and its applicability</li> <li>2. Differentiate between qualitative and quantitative data through scale of measurement.</li> <li>3. Construct graphs and diagrams from data and interpret the result.</li> <li>4. Compute Skewness and Kurtosis of the data to describe nature of data distribution.</li> </ol>	

9	<b>Modules:-</b>	<b>Lect ures</b>
	<b>Module 1: Classification, Tabulation and Presentation of data.</b>	
	<ul style="list-style-type: none"> <li>• Definition and scope of Statistics</li> <li>• Types of data: Qualitative and Quantitative data, Geographical data, Time series data and Crosssection data</li> <li>• Measurement of scales: Nominal, Ordinal, Interval and Ratio.</li> <li>• Primary data and Secondary data</li> <li>• Classification and Tabulation (One way and Two way).</li> <li>• Frequency distributions: Uni-variate and Bi-variate</li> <li>• Diagrammatic representation of data</li> </ul>	15

<p>Simple bar diagram, Multiple bar diagram, Subdivided bar diagram and Pie-chart</p> <ul style="list-style-type: none"> <li>Graphical representation of data</li> <li>Histogram, Frequency Polygon, Frequency Curve, Cumulative frequency curve (Less than and more than type).</li> </ul>	
<p><b>Module 2: Measures of central tendency and Measures of Dispersion</b></p>	<p><b>15</b></p>
<p><b>Measures of central tendency</b></p> <ul style="list-style-type: none"> <li>Concept and Requirements of good measures of central tendency.</li> <li>Arithmetic mean (Simple, weighted mean, combined mean)for grouped and un-grouped data, Merits, demerits and its applicability</li> <li>Positional averages: Median, Mode, and Quartiles (for grouped and un-grouped data) Merits, demerits and its applicability</li> <li>Graphical representation of mode, median and Quartiles.</li> <li>Empirical relation between mean, median and mode (Only statement)</li> </ul> <p><b>Measures of Dispersion</b></p> <ul style="list-style-type: none"> <li>Concept and requirements of good measures of dispersion.</li> <li>Absolute and Relative measures of dispersion: Range, Quartile Deviation , Mean absolute deviation, Variance</li> <li>and Standard deviation (for grouped and un-grouped data) Merits, demerits and its applicability</li> <li>Raw moments and central moments , relation between them upto order four (only statement).</li> <li>Measures of Skewness and Kurtosis: Karl Pearson's measure of Skewness ,</li> </ul> <ul style="list-style-type: none"> <li>Measures of skewness and kurtosis based on moments.(Only formulae) and their interpretation</li> </ul>	

### Reference Books

- David S. : Elementary Probability, Cambridge University Press.
- Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.
- Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillan Publishing Co. Inc.
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- Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II :The World Press Private Limited, Calcutta.
- Mukhopadhyay P. An Introduction to the Theory of Probability, World Scientific Publishing Company, 2011.
- Grewal P. S, Methods of Statistical Analysis, Sterling Publishers, 1990
- S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons

### Format of Question Paper:

#### Internal Continuous Assessment: (20 marks)

Assignment/viva Quizzes, Class Tests, presentation, project, assignment etc	Class Test	Total
05	15	20

#### Semester End Examination: (30 marks)

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

#### Theory Question Paper Pattern:

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

**Sign of the BOS  
Chairman  
Dr. Santosh Gite  
Board of Studies in  
Statistics**

**Sign of the  
Offg. Associate Dean  
Dr. Madhav R. Rajwade  
Faculty of Science &  
Technology**

**Sign of the  
Offg. Dean  
Prof. Shivram S. Garje  
Faculty of Science &  
Technology**

## As Per NEP 2020

# University of Mumbai



<b>Syllabus for Basket of OE</b>	
<b>Board of Studies in Statistics</b>	
<b>UG First Year Programme</b>	
<b>Semester - II</b>	
<b>Title of Paper</b>	<b>Credits 2</b>
<b>I) Introduction to Basic Statistics-II</b>	<b>2 credit</b>
<b>II)</b>	
<b>III)</b>	
<b>From the Academic Year</b>	<b>2024-25</b>

**Open Elective-I**  
**Name of the Course: Introduction to Basic Statistics-II**

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
1	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<p>Introduction:</p> <p>Introduction to Basic Statistics-II course is focuses on to equip students with basic theory of probability and standard discrete distributions. Student will learn basic elementary probability theory, discrete random variables and continuous random variables. Also students will be acquiring knowledge about correlation and predictive analysis.</p> <p>This course will be useful for science, humanity and commerce faculty. This course will be offered other than science faculty students which will be very useful to gain knowledge about basic statistics in their field. This course will be applicable to various field to analyze their basic data structure.</p> <p>This course is focuses practical as well as theoretical aspects of basic statistics along with subjects from psychology, Economics, sociology, commerce, Computers , Mathematics , IT etc.</p> <p>There is growing demand for highly skilled statisticians in the 21st century in many fields including government, banking sector, health sciences, veterinary sciences, agricultural sciences, business, and social sciences etc</p>
2	<b>Vertical :</b>	Minor
3	<b>Type :</b>	Theory
4	<b>Credit:</b>	2 credits ( 1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester )
5	<b>Hours Allotted :</b>	30 Hours
6	<b>Marks Allotted:</b>	50 Marks

7	<p><b>Course Objectives:</b> : Students will be able to,</p> <ol style="list-style-type: none"> <li>1. Understand difference between random and non-random experiment.</li> <li>2. Understand the concept of probability and its applications</li> <li>3. Understand the meaning of continuous and discrete random variable.</li> <li>4. Understand discrete distributions and their properties.</li> <li>5. Solve the examples on probability and probability distributions.</li> </ol>						
8	<p><b>Course Outcomes:</b> On successful completion of this course Students Should be able to,</p> <ol style="list-style-type: none"> <li>1. Identify the types of events</li> <li>2. Calculate probabilities and conditional probabilities.</li> <li>3. Apply the concept of probability in real-life situations.</li> <li>4. Compute the expectation of the uni-variate discrete random variable.</li> <li>5. Write probability mass functions (p.m.f.) of various discrete distribution and their real-life applications.</li> <li>6. Understand the concept and difference between correlation and regression</li> </ol>						
9	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><b>Modules:-</b></th> <th style="text-align: center;"><b>Lect ures</b></th> </tr> </thead> <tbody> <tr> <td><b>Module 1: Elementary Probability Theory</b></td> <td></td> </tr> <tr> <td> <ul style="list-style-type: none"> <li>• Definitions: Trial, random and non-random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: complementary event, equally likely events, certain event, impossible event, independent events, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability.</li> <li>• Conditional probability.</li> <li>• Theorems (without proof ) and their applications:               <ol style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ol> </li> </ul> <p>Simple examples based on all concepts.</p> <ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables.</li> </ul> </td> <td style="text-align: center; vertical-align: top;">15</td> </tr> </tbody> </table>	<b>Modules:-</b>	<b>Lect ures</b>	<b>Module 1: Elementary Probability Theory</b>		<ul style="list-style-type: none"> <li>• Definitions: Trial, random and non-random experiment, sample point and sample space.</li> <li>• Definition of an event and different types of events: complementary event, equally likely events, certain event, impossible event, independent events, mutually exclusive and exhaustive events.</li> <li>• Different definitions of Probability: Classical (Mathematical), Empirical(Statistical) and Axiomatic definitions of Probability.</li> <li>• Conditional probability.</li> <li>• Theorems (without proof ) and their applications:               <ol style="list-style-type: none"> <li>i. Addition theorem on probability for two and three events</li> <li>ii. Multiplication theorem on probability for two events.</li> <li>iii. Bayes' theorem.</li> </ol> </li> </ul> <p>Simple examples based on all concepts.</p> <ul style="list-style-type: none"> <li>• Random variable: discrete and continuous random variables.</li> </ul>	15
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<p>Definition and properties of probability mass function . cumulative distribution function.</p> <ul style="list-style-type: none"> <li>• Expectation and variance of a random variable. Theorems and properties on Expectation and variance of random variables without proof.</li> <li>• Raw and Central moments (definition only) and their relationship. (up to order four).</li> <li>• Joint probability mass function of two discrete random variables. Covariance</li> </ul>	
<p><b>Module 2: Correlation and Regression Analysis.</b></p>	<p><b>15</b></p>
<ul style="list-style-type: none"> <li>• Correlation analysis: Meaning, types of correlation</li> <li>• Scatter Diagram, product moment or Karl Pearson's correlation coefficient and its properties.</li> <li>• Spearman's Rank correlation (With and without ties)</li> <li>• Concept of linear regression, Principle of least squares, fitting of regression lines by method of least squares.</li> <li>• Properties of regression equations.</li> <li>• Relation between regression coefficients and correlation coefficient.</li> <li>• Concept and use of coefficient of determination (<math>R^2</math>).</li> <li>• Introduction of discrete distributions- Discrete Uniform distribution, Binomial distribution, Poisson distribution and their characteristics (without proof) formulae) and their interpretation</li> </ul>	
<p><b>Reference Books</b></p> <ul style="list-style-type: none"> <li>• David S. : Elementary Probability, Cambridge University Press.</li> <li>• Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.</li> <li>• Hogg R.V. and Tannis E.P. : Probability and Statistical Inference. McMillan Publishing Co. Co. Inc.</li> <li>• Pitan Jim : Probability, Narosa Publishing House.</li> <li>• Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II :The World Press Private Limited, Calcutta.</li> </ul>	

- Mukhopadhyay P. An Introduction to the Theory of Probability, World Scientific Publishing Company, 2011.
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- S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons

**Format of Question Paper:**

**Internal Continuous Assessment: (20 marks)**

Assignment/viva Quizzes, Class Tests, presentation, project, assignment etc	Class Test	Total
05	15	20

**Semester End Examination: (30 marks)**

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

**Theory Question Paper Pattern:**

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

**Sign of the BOS  
Chairman  
Dr. Santosh Gite  
Board of Studies in  
Statistics**

**Sign of the  
Offg. Associate Dean  
Dr. Madhav R. Rajwade  
Faculty of Science &  
Technology**

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Offg. Dean  
Prof. Shivram S. Garje  
Faculty of Science &  
Technology**

**As Per NEP 2020**

**University of Mumbai**



**Title of the Program**

**Introduction to Cultural Activities**

**SEM I**

**Syllabus for Two Credit**

**(With effect from the academic year 2024-25)**

## Aims and Objectives

- To study the importance of cultural activities in India.
- To discuss the historical importance of cultural activities.
- To define and describe the overview of cultural practices at Indian and Global level.
- To list the various forms of cultural activities and its applied skills.
- To describe the role of organizations for organizing cultural activities in India.

## Learning Outcomes

- Understand the significance of cultural activities
- Sensitize students towards Indian culture and its preservation
- Apply the knowledge and skills of the cultural activities in their practical life
- Participate in the various cultural activities

## Modules at Glance Semester I

Module No.	Unit	Content	No. of Hours
1	I	Overview to Cultural Activities	05
	II	History of Student Cultural Activities	05
2	III	Forms / Types of Literary and Fine Arts Activities and its Applied Skills	10
	IV	Forms / Types of Performing Arts Activities and its Applied Skills	10
<b>Total No. of Hours</b>			<b>30</b>

Module No.	Unit	Content	No. of Hours
1	<b>I</b>	<b>1.1 Overview to Cultural Activities</b> <ul style="list-style-type: none"><li>• Definition of culture and its manifestations</li><li>• Understanding cultural diversity and inclusivity</li><li>• The role of cultural activities in preserving heritage</li><li>• Overview of Indian cultural practices</li><li>• Overview of global cultural practices</li></ul>	05
	<b>II</b>	<b>2.1 History of Student Cultural Activities</b> <ul style="list-style-type: none"><li>□ Role of student cultural activities</li><li>□ History of student cultural activities in India</li></ul>	05

		<ul style="list-style-type: none"> <li>• Role of AIU in preserving cultural heritage of India</li> <li>• History of student cultural activities in Maharashtra</li> <li>• Student Cultural activities at University of Mumbai</li> </ul>	
2	III	<p><b>3.1 Forms / Types of Literary and Fine Arts Activities and its Applied Skills</b></p> <p><b>3.1.1 Various Forms of Literary Arts</b></p> <ul style="list-style-type: none"> <li>• <b>Elocution:</b> Reading Skills, Soft Skills, Languages, Communication Skills, etc.</li> <li>• <b>Debate:</b> Reading Skills, Soft Skills, Languages, Communication Skills, etc.</li> <li>• <b>Story Writing:</b> Introduction, Plot, Characterization, Presentation, Relevance, Language Style, etc.</li> <li>• <b>Story Telling:</b> Introduction, Plot, Characterization, Presentation, Relevance, Language Style, etc.</li> <li>• <b>Quiz:</b> General Knowledge skills</li> </ul> <p><b>3.1.2 Various Forms of Fine Arts</b></p> <ul style="list-style-type: none"> <li>• <b>Painting:</b> Visualization, Delivery of the Subject, Composition, Colour Application, Presentation and Overall Impact</li> <li>• <b>Collage:</b> Visualization, Delivery of the Subject, Handling of Medium, Composition, Presentation and Overall Impact</li> <li>• <b>Poster Making:</b> Visualization, Delivery of the Subject, Presentation, Tagline and Overall Impact</li> <li>• <b>Clay Modeling:</b> Visualization, Delivery of the Subject, Handling of Medium, Composition, Presentation and Overall Impact</li> <li>• <b>Cartooning:</b> Visualization, Delivery of the Subject, Characters, Synchronization, Colour Application, Composition, Presentation and Overall Impact</li> <li>• <b>Rangoli:</b> Visualization, Delivery of the Subject, Colour Scheme, Elements, Presentation and Overall Impact</li> <li>• <b>Mehendi Designing:</b> Originality, Creativity, Decorative Art with Aesthetic Sense, Presentation and Overall Impact</li> </ul>	10

		<ul style="list-style-type: none"> <li>• <b>Spot Photography:</b> Impact, Composition, Technical Quality and Suitability for the Specific Theme</li> <li>• <b>Installation:</b> Visualization, Delivery of the Subject, Handling of Medium, Synchronization, Composition, Presentation and Overall Impact</li> </ul>	
	<b>IV</b>	<p><b>4.1 Forms / Types of Performing Arts Activities and its Applied Skills</b></p> <p><b>4.1.1 Various Forms of Dance</b></p> <ul style="list-style-type: none"> <li>• <b>Folk Dance:</b> History and Origin of Folk Dance In India, Types and their Uniqueness, Significance of Folk Dance, Folk Dances in Maharashtra</li> <li>• <b>Classical Dance:</b> History of Classical Dance, Types and their Peculiarities, Significance of Classical Dances in India</li> </ul> <p><b>4.1.2 Various Forms of Theatre</b></p> <ul style="list-style-type: none"> <li>• History of Indian Theatre</li> <li>• Types and their Uniqueness</li> <li>• Significance of Indian Theatre</li> <li>• <b>Various Forms of Theatre:</b> One Act Play, Skit, Mime, Mimicry</li> </ul> <p><b>4.1.3 Various Forms of Music</b></p> <ul style="list-style-type: none"> <li>• History of Indian Music,</li> <li>• Types and their Uniqueness,</li> <li>• Significance of Music in India</li> <li>• <b>Various Forms of Music:</b> Classical Singing, Light Vocal, Percussion, Non-Percussion, Nattiyasangeet, Western Vocal, Western Instrumental</li> </ul>	<b>10</b>

### Scheme of Evaluation

The Scheme of Examination shall be of 50 marks. It will be divided into Internal Evaluation (20 marks) and Semester End Examination (30 Marks).

### Semester I (50 Marks, 2 Credits) Internal Evaluation (20 Marks)

Sr. No.	Particulars	Marks
---------	-------------	-------

1	Presentation <b>OR</b> Project <b>OR</b> Assignment	15
2	Participation in Workshop / Conference / Seminar (as decided by the Teacher) <b>OR</b> Participation in Online Workshop / Conference / Seminar (as decided by the Teacher) <b>OR</b> Field Visit <b>OR</b> Attendance	5
<b>Total</b>		<b>20</b>

### Semester End Examination (30 Marks)

Question No.	Particulars	Marks
1	<b>Objective Type Questions (All Units)</b>	6
2	<b>Descriptive Question(s) on Unit I</b> [This question may be divided into sub questions like (a) (b) for 3 Marks + 3 Marks or 4 Marks + 2 Marks pattern]	6
3	<b>Descriptive Question(s) on Unit II</b> [This question may be divided into sub questions like (a) (b) for 3 Marks + 3 Marks or 4 Marks + 2 Marks pattern]	6
4	<b>Descriptive Question(s) on Unit III</b> [This question may be divided into sub questions like (a) (b) for 3 Marks + 3 Marks or 4 Marks + 2 Marks pattern]	6
5	<b>Descriptive Question(s) on Unit IV</b> [This question may be divided into sub questions like (a) (b) for 3 Marks + 3 Marks or 4 Marks + 2 Marks pattern]	6
Total		30

### Reference Books

- 1) Rabindranath Tagore, The Centre of Indian Culture. Rupa and Co, India, 2017.
- 2) Chopra, J. K. Indian Heritage and Culture. Unique Publisher, India, 2013.
- 3) Patnaik Devdatta, Indian Culture, Art and Heritage. Pearson, India, 2021.
- 4) Cassady Marsh, An Introduction to the Art of Theatre: A comprehensive text- Past, Present and Future. Colorado Springs, Colo, 2017.
- 5) Pingle Bhavanrav A., History of Indian Music: with particular reference to theory and practice, Dev Publishers and Distributors, India, 2021.
- 6) Popley Herbert A., The Music of India. Central Archaeological Library, New Delhi, 1921.

- 7) Tomory Edith, History of Fine Arts in India and the West. Orient Longman, Mumbai, 1989.
- 8) Arthur Schopenhauer, The Art of Literature, S. Sonnenschein and co London. 1981.
- 9) M. Keith Booker, A Practical Introduction to Literary theory and Criticism. Routledge. Michigan, 1996.
- 10) Vatsyayan Kapila, Indian Classical Dance. Publications Division, Ministry of Information and Broadcasting, Govt. of India, 1992.
- 11) Phyllia S. Weikart, Teaching folk dance: successful steps. High/Scope Press, Mchigan, 1997.
- 12) Gosvami O., The story of Indian Music, its growth and synthesis. Bombay, New York, Asia Pub. House, 1961.

AC – 20.04.2024  
Item No. – 5.6 (N) Sem II (1a)

## As Per NEP 2020

# University of Mumbai



<b>Syllabus for Basket of AEC</b>	
<b>Board of Studies in Marathi</b>	
<b>UG First Year Programme</b>	
<b>Semester</b>	<b>II</b>
<b>Title of Paper</b>	<b>Credits</b>
लेखन कौशल्ये १- (कार्यालयीन लेखनव्यवहार आणि पत्रव्यवहार)	<b>2</b>
<b>From the Academic Year</b>	<b>2024-25</b>

Sr. No.	Heading	Particulars
1	<b>Description the course :</b>  <b>Including but Not limited to :</b>	<p style="text-align: center;"><b>लेखन कौशल्ये १-</b> <b>(कार्यालयीन लेखनव्यवहार आणि पत्रव्यवहार)</b></p> <p>लेखन ओळख ते लेखन कौशल्य हा बराच मोठा प्रवास आहे. वाचन आणि लेखनाच्या सरावाने, लेखन कौशल्य विकसित करता येते. बहुतेक वेळा आपण मिळवलेले ज्ञान हे लिखित स्वरूपात मांडावे लागते. त्यासाठी आपण लेखन कौशल्याचे योग्य उपयोजन करतो. लेखन म्हणजे मजकूर तंतोतंत उतरवणे नव्हे. एखादे निवेदन, वृत्त, निबंध, पुस्तकाची टिपणे, अर्ज यांसाठी लेखन आवश्यक असते. कार्यालयीन पत्रव्यवहार, कार्यवृत्ते, नोंदी, जाहिरात, टिप्पणी ही सर्व उपयोजित लेखन कौशल्ये आहेत. कार्यालयीन पत्रव्यवहार करणे हे एक वेगळ्या प्रकारचे कौशल्य आहे. त्यातील काही उपयोजन कौशल्यांचा विचार या अभ्यासपत्रिकेत अपेक्षित आहे. कार्यालयीन लेखन व्यवहार आणि पत्रव्यवहार या अभ्यासपत्रिकेत शिकविला जाईल.</p>
2	<b>Vertical :</b>	Ability Enhancement Course
3	<b>Type :</b>	Theory + Practical
4	<b>Credit:</b>	02 (1 credit = 15 Hours for Theory in a semester)
5	<b>Hours Allotted :</b>	30
6	<b>Marks Allotted:</b>	50
7	<b>Course Objectives: ( List some of the course objectives )</b>  १. कार्यालयीन लेखन व्यवहार स्वरूप समजावून सांगणे. २. कार्यालयीन पत्रव्यवहाराचे स्वरूप समजावून सांगणे. ३. प्रभावी कार्यालयीन लेखनासाठी आवश्यक असणाऱ्या क्षमता आणि तंत्रांचा परिचय करून देणे.	
8	<b>Course Outcomes: ( List some of the course outcomes )</b> १. विद्यार्थ्यांना कार्यालयीन लेखन व्यवहाराचे स्वरूप समजेल. २. विद्यार्थ्यांना कार्यालयीन पत्रव्यवहाराचे स्वरूप समजेल. ३. प्रभावी कार्यालयीन लेखनासाठी आवश्यक असणाऱ्या तंत्रांचा विद्यार्थ्यांना परिचय होईल.	
9	<b>Modules:- Per credit One module can be created</b>  <b>घटक एक घटक एक : कार्यालयीन लेखनव्यवहार -</b>  १. जाहीर निवेदन आणि माहितीपत्रक २. इतिवृत्त लेखन ३. टिप्पणी लेखन (६० मिनिटांच्या १५ तासिका) श्रेयांकन १.	

<b>घटक दोन : घटक दोन : पत्रव्यवहार -२</b>	
<p>१.कार्यालयीन/प्रशासनिक पत्र  २. नोकरीसाठी अर्जलेखन  ३. पत्रात्मक लेखन : नवी रूपे (शुभेच्छा, निमंत्रण)  (६० मिनिटांच्या १५ तासिका) श्रेयांकन १.</p>	
<b>10</b>	<b>Text Books:</b> N.A.
<b>11</b>	<b>Reference Books: संदर्भसूची :</b> <ol style="list-style-type: none"> <li>१. प्रशासनिक लेखन, भाषा संचालनालय, महाराष्ट्र शासन, मुंबई, १९६६</li> <li>२. भाषिक सर्जन आणि उपयोजन, राजन गवस, अरुण शिंदे, गोमटेश्वर पाटील, दर्या प्रकाशन, पुणे, २०१२</li> <li>३. परब प्रकाश, व्यावहारिक मराठी, मिथुन प्रकाशन, डोंबिवली पूर्व, मुंबई, १९८९</li> <li>४. नाईक सदानंद, राजभाषा मराठी, व्यावहारिक मराठी, प्रका-नागरी सेवा प्रबोधिनी, मुंबई, २००२</li> <li>५. तावरे स्नेहल (संपा.), व्यावहारिक मराठी, स्नेहवर्धन प्रकाशन, पुणे, चौथी आवृत्ती, २०११</li> <li>६. केतकी मोडक, संतोष शेणई, सुजाता शेणई (संपा.), उपयोजित मराठी, पद्मगंधा प्रकाशन, २०१२</li> <li>७. नसीराबादकर ल. रा., व्यवहारिक मराठी, भाषा विकास संशोधन संस्था, कोल्हापूर २०२३</li> </ol>
<b>12</b>	<b>Internal Continuous Assessment: 40%</b>
	<b>External, Semester End Examination 60% Individual Passing in Internal and External Examination</b>
<b>13</b>	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. ( at least 3 )
	<b>अंतर्गत चाचणी परीक्षा : २० गुण</b> चाचणी परीक्षा /लेखी/ ऑनलाईन/ प्रकल्प/ गृहपाठ - २० गुण
<b>14</b>	<b>Format of Question Paper: for the final examination</b> बहिर्गत परीक्षा ३० गुण (वेळ एक तास) <ul style="list-style-type: none"> <li>● एकूण तीन प्रश्न विचारावेत.</li> <li>● प्रत्येक घटकावर अंतर्गत पर्याय असलेले प्रत्येकी १० गुणांचे दोन प्रश्न विचारावेत.</li> <li>● तिसरा प्रश्न हा घटक १ आणि २ वर आधारित अंतर्गत पर्यायासह दोन टीपा/लघुप्रश्न स्वरूपाचा असावा.</li> </ul>

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Name of the Associate  
Dean  
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Offg. Dean  
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Name of the Faculty**

AC -28/06/2024

Item No. - 5.7 (N)

# University of Mumbai



## Syllabus for Extension Work in Vertical VI - CC

Board of Studies in Extension Work

UG First Year Program

Semester

II

Title of Paper

Credit

Extension Work

2

From the Academic Year

2024-25

## **Introduction**

The National Education Policy (NEP) 2020 is a comprehensive framework introduced by the Government of India to revamp the country's education system. It has replaced the previous National Policy on Education, which has aim to ensure universal access to quality education from preschool to higher education, including vocational education. NEP 2020 emphasizes a more holistic, multidisciplinary, and flexible curriculum which lay emphasis on conceptual understanding rather than rote learning allowing students to choose subjects across disciplines without strict boundaries.

The National Education Policy (NEP) 2020 of India addresses the role of higher education institutions in fostering community engagement and extension work. It highlights the social responsibility of higher education institutions towards their communities. It encourages institutions to engage with local communities, address societal challenges, and contribute to sustainable development. The policy promotes the implementation of outreach programs by higher education institutions to disseminate knowledge, provide services, and support community development. These programs may include literacy campaigns, career development programs, social issues awareness programs, health and hygiene initiatives, skill development workshops, and technology-oriented activities. The policy suggests integrating extension work into the curriculum of higher education programs. This allows learners to gain practical experience, develop leadership skills, and contribute to community development while pursuing their studies. It recognizes incentives to encourage active engagement in community service and extension activities.

Overall, NEP 2020 recognizes the significant role of higher education institutions in promoting community engagement, social responsibility, and sustainable development through extension work. By integrating extension activities into their mission and operations, institutions can contribute to building inclusive and resilient societies.

*Extension work in the context of education refers to the activities and programs conducted by educational institutions to engage with communities, address societal needs, and promote social development.*

### *Aim of Extension Work under NEP:*

- Extension work aims to identify and address the specific needs and challenges faced by communities. NEP 2020 encourages higher education institutions to engage with local communities and contribute to their development by offering programs and services that

address social needs, such as literacy programs, health awareness campaigns, and vocational training.

- Extension work aims to empower communities by providing them with the knowledge, skills, and resources they need to address their own requirements and improve their quality of life.

*Key objectives of Extension Work under NEP:*

- To ensure equal access to quality education and educational opportunities to aspirants.
- To support the government initiatives in achieving universal foundational literacy and numeracy as per sustainable development program.
- To organize remedial programs to address the learning breaches among the youth and provide unending education opportunities.
- To offer more holistic, multidisciplinary, and flexible curricular activities with an emphasis on conceptual understanding and personality development.
- To offer a wide range of activities & promote critical thinking, creativity, and innovation.
- To provide aspirants with multiple pathways for skill development and employment.
- To implement outreach programs to disseminate knowledge, provide services, and support community development.

**Extension Work Activities:**

Extension Work activities introduced by DLLE are a crucial aspect of the educational environment, offering multifaceted benefits that extend beyond academic learning. Many extension activities focus on social issues, sustainability, and environmental conservation. These activities educate the communities on sustainable practices which promote inclusivity and social justice. These activities focus especially on training women in various skills, including entrepreneurship and digital literacy through various vocational skill-oriented projects offered by the department. These activities have significantly contributed to skill development among community members, leading to improved employment opportunities and personality development. Learners participate in extension work activities as part of their curriculum, to gain practical experience and to contribute to community development. Thus, engaging in extension work fosters a sense of social responsibility and civic engagement among the learners and facilitators.

## **THE EXTENSION DIMENSION (Reach to Unreached)**

The college students are enrolled for extension work projects and perform various activities for the **social awareness based on various issues / problems in the society such as Save Girl Child, Pollution, Aids, Global Warming, Environment, Tree Plantation, Importance of Education, Illiteracy, Child Labour, Dowry Deaths, Malnutrition, Watershed Management and so many.** The students are creating awareness about these social problems / issues through various activities such as Street Play, Exhibition, Poster Making, Songs, Speech, Survey, Elocution, and participation in Seminar & Conferences. For this purpose, students are going to remote areas and involve the community and make them aware of our role in eradicating social problems faced by the society and trying to convince the people human duties as an ideal citizen.

To facilitate the sensitization of the student to the socio-cultural realities, the Department offers extension work projects encompassing social issues for the student. There are many Extension Work Projects being offered by the department under the two different units for enhancing the employability and IT skills of the student. The projects are given below for which the details are available on DLLE website at [www.mudlle.ac.in](http://www.mudlle.ac.in)

### **I) Vocational Career Oriented Projects**

1. Career Project [CP]
2. Industry Orientation Project [IOP]
3. Anna Poorna Yojana [APY]
4. Skill Development (SD)

### **II) Community Oriented Projects**

1. Population Education Club (PEC)
2. Survey Research
3. Education for All (EFA- NIOS, IDOL)
4. Environment Education
5. Civic Sense (CS)
6. Consumer Guidance

Given below are the activities / programs to be conducted by the colleges as a part of Extension Work as enlisted topics. The learner will focus on enlisted topics and participate in following activities during Semester II in this academic year.

**ACTIVITIES FOR SEMESTER II = 2 Credits**

Sr. No.	Unit	No. of Lectures
1.	<p><u>Organising &amp; Participation in Training Session</u></p> <p>Every learner should attend the orientation / training session organised by their college for orientation of annual extension work program. Attendance is compulsory. <b>In this session the learners will be oriented about the activities to be conducted during the semester followed by question-and-answer session.</b> The learner must read resource material and guideline carefully and plan his / her activities for the semester during academic year.</p>	2 Lectures
2.	<p><u>Participation in Project /Activities</u> (as given below)</p> <p><b>In this session learners will be oriented about any 5 Topics selected by college (preferably which are not taken in Semester 1) for awareness under Extension Work. The college may select more than 5 topics if the enrolment of learners is more than 200. The learners will participate in activities based on these topics selected by college.)</b></p> <ol style="list-style-type: none"> <li>1. Maharashtra Policy for women.</li> <li>2. Status of women in India. / Women achievers of modern India</li> <li>3. Banking procedures.</li> <li>4. Legal procedures.</li> <li>5. Violence against women / Laws protecting women/ Inheritance laws.</li> <li>6. Child Labour.</li> <li>7. Environment- pollution and its effect / Save Trees and Natural Resources</li> <li>8. Water Harvesting.</li> </ol>	22 Lectures including guidance for practice session, preparations and actual conduct of program.

9. Pollution (Noise pollution / industrial pollution etc.)
10. Issues related to LGBT.
11. HIV –AIDS / Covid 19 etc.
12. Consumer Awareness (Act 2019), Need and Importance
13. E-waste management
14. Stress and Harassment.
15. Global warming
16. Importance of Ethics and Values
17. Old Age Homes / Status of Senior Citizens
18. Distance Education Opportunities
19. First Aid Awareness
20. Voting rights / Human Rights

**Learners will be oriented and motivated to participate in minimum four activities given below based on above topics:**

1. Seminar /conferences, discussion sessions, debate, rallies
2. Competitions (essay/creative writing, elocution, poster/ video/ rangoli making etc. – Minimum 2 competitions)
3. Extension Work group activities of other groups in the college.
4. Prepare your PPT, design your posters / charts.
5. Survey / short term academic courses / innovative programs.
6. Field visit / field work / case studies / developing innovative engineering models / projects
7. Participation in Street Plays
8. Event / hospitality / human resource management program /assignment
9. Novel formulation development (pharmacy),
10. Self-medication survey (pharmacy),

**Learners are required to prepare short videos (duration 3-4 minutes) of the activity where the college will organize such competition.**

	<p><b>The learners will be oriented about various career development opportunities in University of Mumbai, and schemes of student development by the Government.</b></p> <p><b><u>Learners will be oriented and given an opportunity for:</u></b></p> <ul style="list-style-type: none"> <li>- Script writing / Direction for street play.</li> <li>- Composing / Singing (Songs, Powada)</li> <li>- Playing Musical Instrument during the event.</li> <li>- Participation in various college and university level competitions.</li> <li>- Participate in Cultural Performance / Organising Committee for Festival / Programs / Event Management.</li> </ul>	
3	<p><b><u>Participation Video / Stage Performance / Assignment / Report Writing and submission</u></b></p> <ul style="list-style-type: none"> <li>- Present your report / video during the college program.</li> <li>- All learners enrolled in Extension Work can make activity video or stage performance (3-4 minutes duration) creating awareness about any social issues / topics enlisted here followed by assignment / report writing as per format.</li> <li>- <b>College will organise a program in the hall / classroom for all learners and give them an opportunity</b> to present their assignment / report with PPT / video presentation followed by question answer session / test / interview by the college.</li> </ul>	6 Lectures including guidance for practice session, preparations and actual conduct of program.

### **Evaluation Pattern**

#### **Internal Assessment**

<b>Sr. No.</b>	<b>Assessment Criteria</b>	<b>Maximum Marks</b>
1	Attendance, punctuality, completion of hours, participation in programs, presentations and feedback.	10
2	Proficiency in required skill sets, overall performance, submission of written report / assignments and expected development.	10
	Total	20 Marks

## **External Assessment**

**(Based on Extension Work guidelines and five enlisted topics chosen by the college.)**

### **Question Paper Pattern**

**Time: 1.00 Hours**

**Total Marks 30**

**Instructions: 1. All questions are compulsory.**

**2. Figures to the right indicate maximum marks.**

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Q.1. Rewrite the following statement by choosing correct alternative given below. - 06 Marks  
(6 statements. One mark each)

Q.2. Write short Notes On (Any Two out of Four) - 06 Marks

Q.3. Answer the following questions. (Any Three out of Five) - 18 Marks

#### **References:**

- Guidelines for Extension Work published by Department of Lifelong Learning and Extension, University of Mumbai.
- Agricultural Extension: Principles and Methods" by "Ray V. Herren (2008)
- Agricultural Extension by G. S. R. Murthy (2010)
- Introduction to Agricultural Extension by S. S. Acharya (2015)
- Agricultural Extension in Developing Countries by R. W. Snapp (2012)
- Extension Communication and Management by B. M. Panda (2016)

**Sign of BOS Chairman  
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Ad-hoc Board of  
Studies in Extension  
Work**

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AC –28/06/204

Item No. – 5.6 (N)

# University of Mumbai



## Syllabus for Extension Work in Vertical VI - CC

Board of Studies in Extension Work

UG First Year Program

Semester

I

Title of Paper

Credit

Extension Work

2

From the Academic Year

2024-25

## **Introduction**

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3. Education for All (EFA- NIOS, IDOL)
4. Environment Education
5. Civic Sense (CS)
6. Consumer Guidance

Given below are the activities / programs to be conducted by the colleges as a part of Extension Work Syllabus as enlisted. The learner will participate in the following activities during Semester I in this academic year.

**ACTIVITIES FOR SEMESTER I = TOTAL 2 Credits**

Sr. No.	Unit / Activities	No. of Lectures
1	<p><u>Exhibit your talent (Talent Search Program)</u></p> <p><b>Talent Search: Need, Aim and Objectives, Nurturing Talent. Usefulness in Extension Work.</b></p> <p><u>Organizing Talent Search Program.</u></p> <p><b>The Extension Work Teacher will orient the learners and organize such program during lecture hours.</b></p> <p>A talent search program is a critical component of modern human resource management that compel sensitization of self-awareness. By systematically identifying, attracting, and nurturing talent, the colleges can build a workforce that is capable, diverse, and aligned with their strategic goals to achieve objectives of extension work.</p> <p>The following talents / skills are expected from learners to conduct training, extension work and field outreach activities. (Organization, Crowd control, Storytelling, Stage performance (singing, acting, musical instrument playing), Script writing, Poetry composition, Drawing &amp; painting, Collage, Drafting and writing report, PPT presentation and Video Making.</p>	<p>Total 8 Lectures including guidance for preparations and actual conduct of program.</p>
2	<p><u>Organizing &amp; Participation in Training Session and Note Making</u></p> <p>Every learner should attend the training session organized by their college for orientation of annual extension work program. Attendance is compulsory.</p> <p><b>In this session the learners will be oriented about all the extension work topics / activities as enlisted followed by question-and-answer session.</b></p> <p>The learner must read resource material and guidelines carefully</p>	

	<p>and understand the structure of Extension Work under NEP 2020 and accordingly plan for participation in various programs, college level and field outreach activities as given below. Documentation of the activity and report preparation needs to be completed by the learners.</p>	
3	<p><b><u>Self- Introductory Video / Stage Performance</u></b></p> <p><b>All learners enrolled in Extension Work subject can make self-introductory video or stage performance (3-4 minutes duration) stating his / her name, college, areas of interest, reason to join Extension Work, goals, why did he / she choose the particular topic /activity, how will he/she perform &amp; achieve his/her objectives etc. followed by 2-page report writing to be submitted to college. Report writing proforma to be prepared by college.</b></p> <p><b>In this session the learners will be oriented about making self-introductory video/ stage performance, prior preparations, grooming styles and presentation skills, practice sessions and other requirements.</b></p>	
4	<p><b><u>Participation in Activities /Programs</u></b> as given below.</p> <p>- Organize and participate in activities / programs related to five enlisted social issues / government policies. <b>The Learners will be oriented to following activities and motivated to participate in:</b></p> <ol style="list-style-type: none"> <li>1. Seminar /conferences, discussion sessions, debate, rallies</li> <li>2. Competitions (essay/creative writing, elocution, poster/ video/ rangoli making etc.- Minimum 2 competitions)</li> <li>3. Extension Work group activities of other groups in the college.</li> <li>4. Prepare your PPT, design your posters / charts.</li> <li>5. Survey / short term academic courses / innovative programs.</li> </ol> <p><b>Learners should perform and <u>participate in above activities (Minimum 3)</u> related to enlisted topics and strictly follow the guidelines. All the activities / programs must be related to extension work topics to fulfil the DLLE objectives.</b></p>	<p>20 Lectures including guidance for practice session, preparations and actual conduct of program.</p>

	<p><b>The learners will be oriented about <u>any 5 Topics</u> selected by college for awareness under Extension Work. The college may select more than 5 topics if the enrolment of learners is more than 200. The learners will participate in above activities based on these topics selected by college.)</b></p> <ol style="list-style-type: none"> <li>1. Maharashtra Policy for women.</li> <li>2. Status of women in India. / Women achievers of modern India</li> <li>3. Banking procedures.</li> <li>4. Legal procedures.</li> <li>5. Violence against women / Laws protecting women/ Inheritance laws.</li> <li>6. Child Labour.</li> <li>7. Environment- pollution and its effect / Save Trees and Natural Resources</li> <li>8. Water Harvesting.</li> <li>9. Pollution (Noise pollution / industrial pollution etc.)</li> <li>10. Issues related to LGBT.</li> <li>11. HIV –AIDS / Covid 19 etc.</li> <li>12. Consumer Awareness (Act 2019), Need and Importance</li> <li>13. E-waste management</li> <li>14. Stress and Harassment.</li> <li>15. Global warming</li> <li>16. Importance of Ethics and Values</li> <li>17. Old Age Homes / Status of Senior Citizens</li> <li>18. Distance Education Opportunities</li> <li>19. First Aid Awareness</li> <li>20. Election Literacy / Voting rights / Human Rights</li> </ol>	
5	<p><u>Report Writing and Final submission of assignment / report</u></p> <p><b>The learners will be oriented to prepare final assignment / report of the activities to the college.</b> Present report during the college program. Proforma of Report to be prepared by college.</p> <ul style="list-style-type: none"> <li>- College will organize a program in the hall / classroom for all learners and give them opportunity to present their assignment</li> </ul>	2 Lectures

	/ report with PPT presentation followed by question answer session / test / interview by the college.	
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### **Evaluation Pattern**

#### **Internal Assessment**

<b>Sr. No.</b>	<b>Assessment Criteria</b>	<b>Maximum Marks</b>
1	Attendance, punctuality, completion of hours, participation in programs, presentations and feedback.	10
2	Proficiency in required skill sets, overall performance, submission of written report / assignments and expected development.	10
	Total	20 Marks

#### **External Assessment**

**(Based on Extension Work guidelines and five enlisted topics chosen by the college.)**

#### **Question Paper Pattern**

**Time: 1.00 Hours**

**Total Marks 30**

**Instructions: 1. All questions are compulsory.**

**2. Figures to the right indicate maximum marks.**

Q.1. Rewrite the following statement by choosing correct alternative given below. - 06 Marks  
(6 statements. One mark each)

Q.2. Write short Notes On (Any Two out of Four) - 06 Marks

Q.3. Answer the following questions. (Any Three out of Five) - 18 Marks

**References:**

- Guidelines for Extension Work published by Department of Lifelong Learning and Extension, University of Mumbai.
- Agricultural Extension: Principles and Methods" by "Ray V. Herren (2008)
- Agricultural Extension by G. S. R. Murthy (2010)
- Introduction to Agricultural Extension by S. S. Acharya (2015)
- Agricultural Extension in Developing Countries by R. W. Snapp (2012)
- Extension Communication and Management by B. M. Panda (2016)

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