Hindi Seva Mandal's

Shri Sant Gadge Baba
College of Engineering & Technology,

Near Z.T.C., Bhusawal. Dist. - Jalgaon (Maharashtra) Pin - 425203.

An Autonomous Institute Accreditation by NAAC with A+ Grade

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Bucket of Multi – Disciplinary Minor (MDM) Courses

Offers By

Bachelor of Technology (B. Tech.)

in

Computer Science and Engineering

With Effect from the Academic Year 2025-2026

4-year, 8 Semester Full time Programme Choice Based Credit System (CBCS) and Grading System Outcome Based Education Pattern Aligned with

National Education Policy (NEP) 2020

MULTIDISCIPLINARY MINOR COURSES OF COMPUTER SCIENCE & ENGINEERING OFFERED TO THE OTHER DEPARTMENTS										
Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
MDM	BTCS25MD304A	Data Structures and Algorithms	3	-	-	20	20	60	100	3
	BTCS25MD304B	Computer Organization and Architecture	3	-	-	20	20	60	100	3
MDM	BTCS25MD404A	Data Communication and Networks	3	-	-	20	20	60	100	3
	BTCS25MD404B	Object Oriented Programming in Java	3	-	-	20	20	60	100	3
MDM	BTCS25MD505A	Database Management System	3	-	-	20	20	60	100	3
	BTCS25MD505AL	Database Management System Laboratory	-	-	2	50	-	50	100	1
	BTCS25MD505B	Operating System	3	-	-	20	20	60	100	3
	BTCS25MD505BL	Operating System Laboratory	-	-	2	50	-	50	100	1
MDM	BTCS25MD606A	Data Warehouse and Mining	2	-	-	20	20	60	100	2
	BTCS25MD606B	Artificial Intelligence and Machine Learning	2	-	-	20	20	60	100	2
MDM	BTCS25MD705A	Big Data Analytics	2	-	-	20	20	60	100	2
	BTCS25MD705B	Cloud Computing	2	-	-	20	20	60	100	2

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD304A	Data Structures and Algorithms	3	-	-	20	20	60	100	3

Syllabus - BTCS25MD304A Data Structure and Files

Course Description:

This course introduces fundamental concepts of data structures and their applications in computer science. It focuses on the design, implementation, and analysis of various linear and non-linear data structures. The course emphasizes problem-solving techniques, algorithm efficiency, and the use of appropriate data structures for developing efficient software solutions.

Course Objectives:

1. To understand the basic concepts of data structures and abstract data types.
2. To analyze the time and space complexity of algorithms.
3. To implement linear data structures such as arrays, stacks, queues, and linked lists.
4. To understand non-linear data structures such as trees and graphs.
5. To apply searching, sorting, and hashing techniques for efficient data processing.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Understand and apply core concepts of data structures and algorithm analysis.
CO2: Implement and analyze linear data structures such as stacks, queues, and linked lists.
CO3: Apply tree and graph traversal techniques, including BFS, DFS, and recursion.
CO4: Implement and compare searching and sorting algorithms efficiently.
CO5: Apply hashing for effective data storage, retrieval, and collision resolution.

CO–PO Mapping Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	3	3	3	2	2	–	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	1
CO5	3	3	3	2	3	–	–	–	–	–	–	1

Unit I: Introduction to Data Structures **(9 Hours)**

Overview of Data Structures and Abstract Data Types (ADT), Classification of Data Structures: Primitive and Non-Primitive, Linear and Non-Linear Data Structures, Time and Space Complexity: Asymptotic Notations (Big-O, Omega, Theta), Arrays: One-dimensional and Multi-dimensional Arrays, Operations on Arrays: Traversal, Insertion, Deletion, Searching, Merging, Applications of Arrays.

Unit II: Stacks and Queues **(9 Hours)**

Stack: Definition, Operations (Push, Pop, Peek), Array and Linked List Implementation of Stack, Applications of Stack: Expression Evaluation, Infix to Postfix Conversion, Recursion, Queue: Definition and Operations, Types of Queues: Simple Queue, Circular Queue, Priority Queue, Deque, Array and Linked List Implementation of Queues, Applications of Queues

Unit III: Linked Lists **(9 Hours)**

Introduction to Linked Lists, Types of Linked Lists: Singly, Doubly, Circular Linked Lists, Operations: Insertion, Deletion, Traversal, Searching, Memory Representation and Dynamic Allocation, Comparison between Arrays and Linked Lists, Applications of Linked Lists

Unit IV: Trees and Graphs **(9 Hours)**

Introduction to Trees: Terminology and Properties, Binary Trees and Binary Search Trees, Tree Traversal Techniques: Inorder, Preorder, Postorder, Introduction to Graphs: Definitions and Terminology, Graph Representations: Adjacency Matrix and Adjacency List, Graph Traversal Algorithms: Breadth First Search (BFS), Depth First Search (DFS), Applications of Trees and Graphs

Unit V: Searching, Sorting and Hashing **(9 Hours)**

Searching Techniques: Linear Search, Binary Search, Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Advanced Sorting: Merge Sort, Quick Sort, Comparison of Sorting Algorithms, Introduction to Hashing, Hash Functions and Collision Resolution Techniques, Applications of Hashing

Recommended Textbooks:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C*, Pearson Education.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, *Fundamentals of Data Structures in C*, Universities Press.
3. Reema Thareja, *Data Structures Using C*, Oxford University Press.

Reference Books:

1. Thomas H. Cormen et al., *Introduction to Algorithms*, MIT Press.
2. Seymour Lipschutz, *Data Structures*, McGraw-Hill.
3. Jean-Paul Tremblay and Paul G. Sorenson, *An Introduction to Data Structures with Applications*, McGraw-Hill.

NPTEL Course: Data Structures and Algorithms Design, By Prof. Nitin Saxena | IIT Kanpur,
Link - https://nptel.ac.in/courses/106104697

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD304B	Computer Organization and Architecture	3	-	-	20	20	60	100	3

Syllabus - BTCS25MD304B Computer Organization and Architecture

Course Description:

This course provides a thorough understanding of the structure, organization, and operation of modern computer systems. It covers fundamental concepts of computer architecture, instruction set design, CPU organization, memory hierarchy, input–output systems, and performance measures. Students will gain knowledge of computer system components, instruction execution, pipelining, cache and virtual memory management, and I/O techniques. The course also introduces multicore and multiprocessor systems, preparing students to analyze and design efficient computing systems.

Course Objectives:

1. To understand the basic structure and functional units of a computer system and their operational concepts.
2. To analyze instruction set architectures, including instruction formats, addressing modes, and control flow mechanisms.
3. To study CPU internal organization, including ALU design, register organization, control unit operations, and pipelining.
4. To explore memory hierarchy, cache organization, virtual memory, and performance optimization techniques.
5. To understand input–output organization, secondary storage devices, and concepts of multicore and multiprocessor architectures.

Course Outcomes (COs):

CO1: Explain the structure, functional units, and performance of a computer system.
CO2: Analyze instruction set architectures, instruction formats, addressing modes, and sequencing.
CO3: Understand CPU organization, ALU operations, and control unit design.
CO4: Describe memory hierarchy, cache organization, and virtual memory techniques.
CO5: Explain I/O organization, secondary storage, and multicore/multiprocessor concepts.

CO–PO Mapping Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Basic Structure of Computers **(9 Hours)**

Computer system organization and functional units, basic operational concepts, and bus structures, interconnection schemes, clock rate, CPI, MIPS, and benchmarks, Von Neumann and Harvard architectures, instruction cycle, interrupt handling, overview of RISC and CISC architectures.

Unit II: Instruction Set Architecture **(9 Hours)**

Instruction set design issues, instruction formats, addressing modes. data transfer, arithmetic, logical, and control instructions, instruction sequencing, and control flow. stack organization, subroutine handling, conceptual study of MIPS , x86 instruction sets.

Unit III: Central Processing Unit **(9 Hours)**

CPU internal organization, register organization, data paths, ALU design. Topics include fixed-point and floating-point arithmetic, control unit design (hardwired and microprogrammed), instruction execution cycle, pipelining concepts, pipeline hazards, and basic remedies.

Unit IV: Memory Organization **(9 Hours)**

Memory hierarchy, semiconductor memories (RAM and ROM), cache memory organization, mapping techniques, cache replacement and write policies, virtual memory concepts. paging, segmentation, and memory performance analysis.

Unit V: Input–Output Organization **(9 Hours)**

Introduces I/O system fundamentals, programmed I/O, interrupt-driven I/O, and DMA and DMA controller. I/O interfaces and controllers, bus arbitration techniques.

Recommended Textbooks:

1. William Stallings, Computer Organization and Architecture, Pearson Education.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, McGraw-Hill Education.

Reference Books:

1. John L. Hennessy and David A. Patterson, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann.
2. Andrew S. Tanenbaum and Todd Austin, Structured Computer Organization, Pearson.
3. M. Morris Mano, Computer System Architecture, Pearson.
4. Behrooz Parhami, Computer Architecture: From Microprocessors to Supercomputers, Oxford University Press.
5. Dezső Sima, Terence Fountain, Peter Kacsuk, Advanced Computer Architectures, Pearson.

NPTEL Course: computer architecture and organization by Prof. Indranil Sengupta, Prof. Kamalika Datta | IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc22_cs88/preview

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD404A	Data Communication and Networks	3	-	-	20	20	60	100	3

Syllabus - BTCS 25MD404A Data Communication and Networks

Course Description

This course introduces the fundamental concepts of data communication and computer networks. It covers layered network architecture, transmission media, data link control, routing algorithms, transport protocols, application layer services, and basic network security mechanisms. The course provides both theoretical understanding and practical insights into modern networking technologies and protocols used in real-world communication systems.

Course Objectives

1. To understand the fundamentals of data communication and networking models.
2. To study transmission media, switching techniques, and physical layer concepts.
3. To analyze data link and network layer protocols including error control and routing.
4. To understand transport layer protocols and congestion control mechanisms.
5. To explore application layer protocols and basic network security concepts.

Course Outcomes

CO1: Explain layered network architecture and physical layer concepts.
CO2: Apply data link layer mechanisms such as framing, error control, and access control.
CO3: Analyze IP addressing schemes and routing algorithms.
CO4: Understand transport layer protocols and congestion control techniques.
CO5: Describe application layer protocols and basic network security mechanisms.

CO–PO Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	2	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	3	3	2	2	2	–	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

UNIT I: Introduction & Physical Layer **(9 Hours)**

Data Communication Components, Data Flow, Network Topologies, OSI Model and TCP/IP Model comparison, Transmission Media (Guided and Unguided), Switching Techniques (Circuit Switching and Packet Switching), Digital Transmission, Modulation Techniques.

UNIT II: Data Link Layer **(9 Hours)**

Framing Techniques, Error Control (CRC, Checksum), Flow Control (Stop-and-Wait, Sliding Window), Access Control Protocols: ALOHA, CSMA/CD, Ethernet Standards (IEEE 802.3), Wi-Fi (IEEE 802.11), Switching Concepts and VLANs.

UNIT III: Network Layer **(9 Hours)**

Logical Addressing (IPv4 and IPv6), Subnetting, Supernetting, Routing Algorithms (Distance Vector, Link State, OSPF, BGP), ARP, RARP, ICMP, DHCP.

UNIT IV: Transport Layer **(9 Hours)**

Process-to-Process Delivery, UDP (User Datagram Protocol), TCP (Transmission Control Protocol) – Segment Structure, Three-Way Handshake, Flow Control, Congestion Control (Leaky Bucket and Token Bucket).

UNIT V: Application Layer **(9 Hours)**

Domain Name System (DNS), HTTP/HTTPS, FTP, SMTP, POP3, Network Security Basics: Cryptography, Digital Signatures, Firewalls.

TEXT BOOKS:

1. Data Communications and Networking – Behrouz A. Forouzan (McGraw Hill).
2. Computer Networks – Andrew S. Tanenbaum (Pearson).

REFERENCE BOOKS:

1. Data and Computer Communications – William Stallings (Pearson).

NPTEL Course: Computer Networks & Internet Protocol by Prof. Sujoy Ghosh (IIT Kharagpur) or Prof. Chetan Parikh (IIT Bombay), https://onlinecourses.nptel.ac.in/noc26_cs35/preview

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD404B	Object Oriented Programming in Java	3	-	-	20	20	60	100	3

Syllabus - BTCS 25MD404B Object Oriented Programming in Java

Course Description:

This course introduces the principles of Object-Oriented Programming (OOP) using Java. It covers fundamental programming concepts, object-oriented design, exception handling, multithreading, GUI programming, networking, and database connectivity. The course emphasizes practical implementation to develop robust, secure, and scalable Java-based applications suitable for real-world computing environments.

Course Objectives:

1. To understand object-oriented programming principles and Java fundamentals.
2. To develop Java programs using classes, objects, inheritance, and polymorphism.
3. To implement exception handling, file handling, and multithreaded programming concepts.
4. To design graphical user interfaces using AWT and Swing.
5. To develop network-based and database-driven applications using Java.

Course Outcomes:

CO1: Understand and apply object-oriented programming concepts using Java.
CO2: Develop Java programs incorporating encapsulation, inheritance, and polymorphism.
CO3: Implement exception handling, multithreading, and file handling mechanisms in Java applications.
CO4: Design GUI-based applications using AWT and Swing components.
CO5: Develop networking and database connectivity solutions using Java technologies.

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CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	–	–	–	–	–	–	1
CO2	3	3	3	1	2	–	–	–	–	–	–	1
CO3	3	2	2	2	3	–	–	–	–	–	–	1
CO4	3	2	3	1	2	–	–	–	–	1	–	1
CO5	3	3	2	2	3	–	–	–	–	1	1	1

Unit I: Introduction to Object-Oriented Programming and Java Fundamentals (9 Lectures)

Overview of Object-Oriented Programming (OOP) concepts, Features of Java and Java Virtual Machine (JVM), Java program structure and execution flow, Data types, variables, operators, and control statements, Arrays and strings, Introduction to classes and objects, Simple Java programs and compilation process.

Unit II: Input–Output Handling and Encapsulation in Java (9 Hours)

Java I/O streams: byte streams and character streams, File handling in Java, Scanner and Buffered I/O classes, Concept of encapsulation, Access specifies and data hiding, Getter and setter methods, Practical examples demonstrating encapsulation.

Unit III: Inheritance and Exception Handling (9 Hours)

Basics of inheritance, Types of inheritance in Java, Method overriding and use of super keyword, Polymorphism through inheritance, Exception handling concepts, Try–catch–finally blocks, User-defined exceptions.

Unit IV: Multithreading, Applets, and GUI Programming (9 Hours)

Introduction to multithreaded programming, Thread lifecycle and thread creation methods, Thread synchronization, Introduction to Java Applets, Servlets overview and life cycle, Abstract Windowing Toolkit (AWT), Java Swing components and event handling.

Unit V: Networking, Database Connectivity, Interfaces, and Packages **(9 Hours)**

Java networking basics, URL and socket programming, Client–server communication, Java Object Database Connectivity (ODBC/JDBC), Database connectivity architecture, Interfaces in Java, Packages and their role in software development.

Text Books

1. E. Balagurusamy, *Programming with Java: A Primer*, McGraw-Hill Education, Latest Edition.
2. Herbert Schildt, *Java: The Complete Reference*, McGraw-Hill Education, Latest Edition.

Reference Books

1. Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Pearson Education, Latest Edition.
2. Cay S. Horstmann, *Core Java Volume II – Advanced Features*, Pearson Education, Latest Edition.
3. Kathy Sierra & Bert Bates, *Head First Java*, O'Reilly Media, Latest Edition.
4. Y. Daniel Liang, *Introduction to Java Programming*, Pearson Education, Latest Edition.
5. Jim Keogh, *J2EE: The Complete Reference*, McGraw-Hill Education.

NPTEL Course : Programming in Java By Prof. Debasis Samanta, IIT Kharagpur.
Link: https://onlinecourses.nptel.ac.in/noc20_cs58/preview

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS 25MD505A	Database Management System	3	-	-	20	20	60	100	3

Syllabus : BTCS 25MD505A Database Management System

Course Description:

This course provides a comprehensive introduction to database systems, focusing on the design, implementation, and management of databases. It covers fundamental concepts of database systems, data modeling using the Entity-Relationship (ER) model, relational data models, relational algebra and calculus, SQL programming, normalization, indexing, hashing, and transaction management. Students will gain the skills to design and implement robust, efficient, and secure database systems for real-world applications.

Course Objectives:

1. To understand the purpose, applications, and architecture of database systems.
2. To learn data modeling techniques using the Entity-Relationship (ER) model.
3. To understand relational data models, relational algebra, and calculus.
4. To gain proficiency in SQL for data definition, manipulation, and querying.
5. To apply normalization, indexing, and hashing techniques for database design.
6. To understand transaction management, concurrency control, and recovery mechanisms.

Course Outcomes (COs):

CO1: Explain fundamental concepts, architecture, and applications of database systems.
CO2: Design databases using ER modeling and convert ER diagrams to relational tables.
CO3: Apply relational algebra, calculus, and SQL for data retrieval and manipulation.
CO4: Implement normalization, indexing, and hashing for efficient database design.
CO5: Apply transaction management, including ACID properties, concurrency control, and recovery.

CO–PO Mapping Matrix:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Introduction to Database Systems **(9 Hours)**

Database System Applications, Purpose of Database Systems, View of Data, Types of Database Models, Database Architecture,Key in DBMS, Data modeling using the Entity Relationship Model.Notation for ER diagram, E-R Diagrams, Mapping Cardinality, Extended ER model,Generalization, Aggregation, Reduction of an ER diagrams to tables.

Unit II: Relational Data Model, Relational Algebra, and Calculus **(9 Hours)**

Overview of SQL, Basic Structure of SQL Queries, SQL Data Types and Schema,SQL Data Definition and Data Manipulation Language, Basic Operators in SQL, Set Operations, Constraints,Aggregate Functions, Nested Sub queries, SQL Join Expressions, Views, Functions and Procedures, Triggers,

Unit III: Introduction to SQL **(9 Hours)**

SQL intro, data definition queries, data manipulation queries, and the basic structure of SQL queries. Topics include basic operators, set operations, null values, aggregate functions, nested subqueries, database modification, SQL join expressions, views, integrity constraints, data types, schema design, authorization, and advanced SQL concepts such as functions, procedures, and triggers.

Unit IV: File Organization, Indexing, and Hashing in Relational Databases **(9 Hours)**

Normalization: Features of good relational designs, Functional Dependency Theory, Multivalued Dependencies, Normal forms, First, Second, Third normal forms, BCNF, Database Design Process: File Organization, Ordered Indices, B+tree Index files, B Tree Index File, Static Hashing, Dynamic Hashing,

Unit V: Transaction Management **(9 Hours)**

Transaction Concept, A simple Transaction Model, Transaction Atomicity and Durability, Transaction Isolation, ACID Properties, Serializability Concurrency Control Techniques: Lock based Protocols, Deadlock handling, Time stamp-Based Protocols, Recovery System.

Recommended Textbooks:

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, *Database System Concepts*, McGraw-Hill, 6th Edition, 2011.

Reference Books:

1. Navathe, *Fundamentals of Database Systems*, Addison-Wesley, 6th Edition, 2012.
2. Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, McGraw-Hill, 3rd Edition, 2003.
3. Joel Murach, *Murach's Oracle SQL and PL/SQL for Developers*, 2nd Edition, 2014.
4. Wiederhold, *Database Design*, McGraw-Hill, 2nd Edition, 1983.
5. Mark L. Gillenson, *Fundamentals of Database Management Systems*, Wiley, 2nd Edition, 2011.
6. Serge Abiteboul, Richard Hull, Victor Vianu, *Foundations of Databases*, Addison-Wesley.

NPTEL Course : Database Management System, Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay IIT Kharagpur, https://nptel.ac.in/courses/106106220

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
PCC	BTCS25MD505AL	Database Management System Lab	-	-	2	50	-	50	100	1

Syllabus : BTCS25MD505AL Database Management System Lab

List of Experiments :

1. Demonstrating the use of DDL queries to create the database.
2. Use of various SQL DML queries to select, insert, update, or delete data from the database.
3. To create database views and perform various operations on them.
4. To apply, modify, and delete various constraints in SQL on the database.
5. Use of set operators and functions with `HAVING`, `GROUP BY`, and `ORDER BY` clauses in SQL.
6. Writing different PL/SQL blocks.
7. Writing and using functions in PL/SQL.
8. Writing and using stored procedures in PL/SQL.
9. Use of triggers in DBMS.
10. Use of cursors in PL/SQL.

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD505B	Operating System	3	-	2	20	20	60	100	3

Syllabus : BTCS 25MD505B Operating System

Course Description:

This course introduces the fundamental concepts of Operating Systems including process management, memory management, synchronization, deadlocks, file systems, and disk management. It provides an understanding of how operating systems manage hardware resources and provide services to application programs. The course emphasizes practical concepts and case studies relevant to modern operating systems such as Linux/UNIX.

Course Objectives

1. To understand the basic structure and functions of operating systems.
2. To study process management and CPU scheduling algorithms.
3. To analyze synchronization mechanisms and deadlock handling techniques.
4. To understand memory management and virtual memory concepts.
5. To explore file systems, I/O systems, and disk scheduling techniques.

Course Outcomes

CO1: Explain the structure and functions of operating systems.
CO2: Apply CPU scheduling and process management techniques.
CO3: Analyze synchronization problems and deadlock handling methods.
CO4: Evaluate memory management and page replacement algorithms.
CO5: Describe file system organization, I/O management, and disk scheduling algorithms.

CO–PO Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	1	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	1
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Introduction to Operating Systems **(9 Hours)**

Introduction to Operating Systems, Objectives and Functions of an Operating System, Evolution of Operating Systems, Types of Operating Systems: Batch, Multiprogramming, Time-Sharing, Real-Time, Distributed, Embedded OS, Operating System Structures: Monolithic, Layered, Microkernel, System Calls and OS Services, User and Kernel Mode.

Unit II: Process Management and CPU Scheduling **(9 Hours)**

Process Concept, Process States and State Transitions, Process Control Block (PCB), Threads and Multithreading Models, CPU Scheduling: Scheduling Criteria, Scheduling Algorithms: FCFS, SJF, Priority, Round Robin, Inter-Process Communication (IPC), Introduction to Synchronization.

Unit III: Process Synchronization and Deadlocks **(9 Hours)**

Critical Section Problem, Synchronization Hardware, Semaphores and Classical Problems, Monitors, Deadlocks: System Model, Deadlock Characterization, Deadlock Prevention, Avoidance (Banker's Algorithm), Deadlock Detection and Recovery.

Unit IV: Memory Management **(9 Hours)**

Memory Management Concepts, Logical vs Physical Address Space, Contiguous Memory Allocation, Paging and Segmentation, Virtual Memory, Demand Paging, Page Replacement Algorithms: FIFO, LRU, Optimal, Thrashing.

Unit V: File System, I/O & Disk Management **(9 Hours)**

File Concept and Access Methods, File System Structure, Directory Structure and Implementation, File Allocation Methods, Free Space Management, I/O Systems, Disk Scheduling Algorithms: FCFS, SSTF, SCAN, C-SCAN, Case Study: Linux / UNIX File System (Overview).

Text Books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, Wiley, Latest Edition.
2. William Stallings, Operating Systems: Internals and Design Principles, Pearson Education.

Reference Books

1. Andrew S. Tanenbaum, Modern Operating Systems, Pearson Education.
2. D. M. Dhamdhere, Operating Systems – A Concept-Based Approach, Tata McGraw-Hill.
3. Harvey M. Deitel, Operating Systems, Pearson Education.

NPTEL Course : Introduction to Operating Systems, Prof. Chester Rebeiro, IITMadras,
https://nptel.ac.in/courses/106106144

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
AEC	BTCS25MD505BL	Operating System Lab	-	-	2	50	-	50	100	1

Syllabus : BTCS25MD505BL Operating System Lab

Pre-requisites

- Proficiency in C, Python programming, Java Programming.
- Fundamental knowledge of Operating Systems (Linux/Windows command line).

1. Study basic functions of an Operating System and different types of Operating Systems.
2. Write a simple program to show system calls like process ID and process creation.
3. Write a program to create a process and show parent and child process.
4. Write a program for FCFS CPU scheduling.
5. Write a program for Round Robin CPU scheduling.
6. Write a simple program to show process synchronization using a semaphore.
7. Write a program to show deadlock avoidance using Banker's Algorithm.
8. Write a program for FIFO page replacement.
9. Write a program for LRU page replacement.
10. Write a program for disk scheduling using FCFS or SSTF.

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS 25MD606A	Data warehouse and Mining	2	-	-	20	20	60	100	2

Syllabus : BTCS25MD606A Data warehouse and Mining

Course Description:

This course provides an in-depth study of concepts, techniques, and tools used in data warehousing and data mining, focusing on the management, analysis, and extraction of knowledge from large volumes of data. The course explores the design, implementation, and maintenance of data warehouses, along with the methods for discovering patterns, trends, and insights from data.

Course Objectives:

1. Understand the fundamentals of data warehousing and data mining.
2. Design and implement data warehouses.
3. Apply data preprocessing techniques.
4. Use data mining algorithms for knowledge discovery.Analyze real-world data to support business intelligence.
5. Understand ethical, legal, and practical considerations.
6. Utilize modern tools and technologies

Course Outcomes:

CO1: Understand data warehousing concepts.
CO2: Design and implement data warehouses
CO3: Perform data preprocessing for mining.
CO4: Analyze and interpret mined knowledge.
CO5: Apply data mining techniques.

CO–PO Mapping Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Introduction to Data Warehousing **(7 Hours)**

Introduction to data warehousing, Need for data warehousing, Operational database vs Data warehouse, Characteristics of a data warehouse, Data warehouse architecture, Components of a data warehouse, Data marts and types of data marts, Applications of data warehousing,

Unit II: Data Warehouse Modeling and OLAP **(7 Hours)**

Data warehouse design process, Dimensional modeling concepts, Fact tables and dimension tables ,Star schema and snowflake schema, Schema comparison, Introduction to OLAP, OLAP operations: Roll-up, Drill-down, Slice, Dice, Pivot, OLAP vs OLTP.

Unit III: Introduction to Data Mining **(7 Hours)**

Introduction to data mining, Data mining tasks and applications, KDD (Knowledge Discovery in Databases) process, Data preprocessing: Data cleaning, Data integration, Data transformation, Data reduction, Types of data, Data mining issues and challenges.

Unit IV: Data Mining Techniques – Classification & Clustering **(7 Hours)**

Classification concepts, Decision tree induction, Bayesian classification, k-Nearest Neighbor (k-NN), Introduction to clustering, Types of clustering, Partitioning methods: k-means algorithm, Hierarchical clustering.

Unit V: Association Rules and Advanced Topics **(7 Hours)**

Association rule mining, Market basket analysis, Frequent itemset generation, Apriori algorithm, Introduction to web mining, Introduction to text mining, Applications of data mining, Ethical and social issues in data mining.

Textbooks

1. Jiawei Han, Micheline Kamber, Jian Pei – Data Mining: Concepts and Techniques, Morgan Kaufmann
2. Ralph Kimball and Margy Ross – The Data Warehouse Toolkit, Wiley

Reference Books

1. Alex Berson and Stephen J. Smith – Data Warehousing, Data Mining and OLAP, McGraw-Hill
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar – Introduction to Data Mining, Pearson
   Sam Anahory and Dennis Murray – Data Warehousing in the Real World, Pearson

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD606B	AI & Machine Learning	3	-	-	20	20	60	100	2

Syllabus - BTCS25MD606B - AI & Machine Learning

Course Description:

This course provides a comprehensive introduction to Artificial Intelligence (AI) and Machine Learning (ML). It covers the fundamental concepts, history, and problem-solving techniques in AI, supervised and unsupervised learning methods, probabilistic and kernel-based learning, computational learning theory, and ensemble learning. Students will learn to design and implement machine learning models for real-world problems, including regression, classification, clustering, and recommendation systems.

Course Objectives:

1. To understand the fundamental concepts, history, and representation methods of Artificial Intelligence.
2. To learn problem-solving techniques in AI, including state space search, production systems, and rule-based reasoning.
3. To gain knowledge of supervised learning techniques such as linear regression, decision trees, instance-based learning, and collaborative filtering.
4. To understand probabilistic learning, logistic regression, Support Vector Machines (SVM), and kernel methods.
5. To explore computational learning theory, PAC learning models, VC dimension, and ensemble learning.
6. To implement unsupervised learning techniques including k-means, hierarchical clustering, and Gaussian mixture models.

Course Outcomes (COs):

CO1: Understand AI concepts, history, and problem-solving techniques.
CO2: Apply supervised learning methods for practical problems.
CO3: Analyze probabilistic and kernel-based learning methods.
CO4: Understand computational learning theory and implement ensemble learning.
CO5: Apply unsupervised learning for clustering and pattern discovery.

CO–PO Mapping Matrix:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit 1: Introduction to Artificial Intelligence **(7 Hours)**

Definitions, history, and applications of AI. AI representation techniques, Turing test, and evaluation of machine intelligence. problem-solving methods, state space search, problem characteristics, production systems, and production rules. Practical examples like Water Jug Problem to illustrate concepts.

Unit 2: Supervised and Instance-Based Learning **(7 Hours)**

Basic concepts and types of learning, hypothesis space, inductive bias, and evaluation methods , cross-validation. Linear regression, decision tree induction, overfitting and model generalization. Instance-based learning, feature reduction, collaborative filtering for recommendation systems.

Unit 3: Probabilistic and Kernel-Based Learning **(7 Hours)**

Probability theory and Bayesian learning, logistic regression, Support Vector Machines (SVM), kernel functions, and kernel SVM for non-linear classification.

Unit 4: Computational Learning Theory and Ensemble Methods (7 Hours)

Introduction to computational learning theory , PAC (Probably Approximately Correct) learning model, sample complexity, VC dimension. Ensemble learning techniques.

Unit 5: Clustering and Unsupervised Learning (7 Hours)

Clustering and unsupervised learning techniques such as k-means, adaptive hierarchical clustering, and Gaussian mixture models. Applications in data grouping, pattern recognition, and analysis are included.

Textbooks:

1. Tom Mitchell, Machine Learning, First Edition, McGraw Hill, 1997.
2. Elaine Rich, Kevin Knight, and Shiva Shankar B. Nair, Artificial Intelligence, 3rd Edition, TMH.

Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition.
2. B. Yegnanarayana, Artificial Neural Network, PHI.

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MDM	BTCS25MD705A	Big Data Analytics	2	-	-	20	20	60	100	2

Syllabus : BTCS25MD705A Big Data Analytics

Course Description:

This course provides a comprehensive introduction to the concepts, technologies, and applications of Big Data Analytics. It focuses on the collection, storage, processing, and analysis of large, complex, and high-velocity datasets to extract meaningful insights and support data-driven decision-making.

Course Objectives:

1. To understand the fundamental concepts, characteristics, and challenges of Big Data (Volume, Velocity, Variety, Veracity, and Value).
2. To learn the architecture and components of Big Data ecosystems, including distributed storage and processing systems.
3. To gain knowledge of Hadoop, Spark, and other distributed computing frameworks.
4. To understand NoSQL databases and data warehousing techniques for large-scale data management.
5. To apply data preprocessing, cleaning, and transformation techniques for big datasets.
6. To perform exploratory data analysis and statistical analysis on large-scale data.
7. To implement machine learning algorithms for big data applications.

Course Outcomes:

CO1: Understand concepts, characteristics, and challenges of Big Data.
CO2: Implement distributed storage and processing using Hadoop and Spark.
CO3: Apply preprocessing and management techniques on large datasets.
CO4: Analyze big data using statistics and machine learning.
CO5: Use NoSQL, data warehouses, and cloud platforms for scalable analytics..

CO–PO Mapping Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Introduction to Big Data **(7 Hours)**

Introduction to Big Data, Evolution of data and data analytics, Characteristics of Big Data (5 V's: Volume, Velocity, Variety, Veracity, Value), Types of data: structured, semi-structured, unstructured, Big Data vs Traditional Data Processing, Applications of Big Data, Challenges in Big Data analytics

Unit II: Big Data Architecture and Ecosystem **(7 Hours)**

Big Data architecture overview, Distributed computing concepts, Hadoop ecosystem overview, Hadoop Distributed File System (HDFS), MapReduce programming model (concepts), YARN architecture, Introduction to NoSQL databases

Unit III: Big Data Storage and Processing Tools **(7 Hours)**

HDFS architecture and components, Data ingestion tools: Sqoop and Flume, Data processing fameworks: MapReduce overview, Apache Spark introduction, Batch processing vs Stream processing, Introduction to Hive and Pig, Use cases of Big Data tools

Unit IV: Big Data Analytics and Data Processing **(7 Hours)**

Data preprocessing in Big Data, Data cleaning and transformation, Descriptive analytics, Predictive analytics overview, Introduction to machine learning in Big Data, Spark MLlib (concepts), Data visualization basics for Big Data.

Unit V: Advanced Topics, Applications, and Security **(7 Hours)**

Real-time Big Data analytics, Streaming tools: Kafka and Spark Streaming (overview), Big Data analytics in cloud platforms, Big Data security and privacy issues, Ethical issues in Big Data, Industry use cases: healthcare, finance, retail, social media, Future trends in Big Data analytics.

Textbooks

1. Seema Acharya and Subhashini Chellappan – *Big Data and Analytics*, Wiley
2. Tom White – *Hadoop: The Definitive Guide*, O'Reilly Media

Reference Books

1. Viktor Mayer-Schönberger and Kenneth Cukier – *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, John Murray
2. Anand Rajaraman and Jeffrey Ullman – *Mining of Massive Datasets*, Cambridge University Press
3. Bill Chambers and Matei Zaharia – *Spark: The Definitive Guide*, O'Reilly Media
4. Eric Sammer – *Hadoop Operations*, O'Reilly Media

NPTEL Course: Big Data Computing –Prof. Rajiv Misra IIT Kanpur, https://nptel.ac.in/courses/106104189

Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
MD	BTCS25MD705B	Cloud Computing	2	-	-	20	20	60	100	2

Syllabus : BTCS25MD705B Cloud Computing

Course Description:

This course provides a comprehensive introduction to the principles, technologies, and applications of Cloud Computing. It covers fundamental concepts, service and deployment models, virtualization, cloud architecture, and modern cloud platforms. The course also emphasizes cloud storage, resource management, scalability, and security issues, along with emerging trends such as serverless computing, edge computing, and container orchestration. It equips learners with the knowledge required to design, deploy, and manage cloud-based solutions effectively.

Course Objectives:

1. To understand the fundamental concepts, characteristics, and evolution of Cloud Computing.
2. To learn cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid, Community).
3. To gain knowledge of virtualization technologies, hypervisors, and cloud architecture.
4. To understand cloud storage systems, service delivery models, and distributed storage mechanisms.
5. To study resource management, scalability, load balancing, and fault tolerance in cloud environments.
6. To analyze cloud security challenges, authentication, authorization, and data privacy issues.
7. To explore modern cloud platforms and emerging trends such as serverless computing, microservices, and edge computing.

Course Outcomes:

CO1: Understand cloud concepts, characteristics, and service models.

CO2: Apply virtualization techniques and cloud architecture components.

CO3: Demonstrate knowledge of cloud storage, service delivery, and distributed systems.

CO4: Implement resource management, scalability, and security in cloud environments.

CO5: Evaluate cloud platforms and use emerging technologies for cloud applications.

CO–PO Mapping Matrix:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	1
CO2	3	3	2	1	2	–	–	–	–	–	–	1
CO3	2	3	2	2	2	1	–	–	–	–	–	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2
CO5	2	2	2	1	2	1	1	1	–	1	1	2

Unit I: Introduction to Cloud Computing **(7 Hours)**

Fundamentals of Cloud Computing, history and evolution of cloud computing , Core concepts, characteristics, and benefits. cloud service models IaaS, PaaS, and SaaS, Deployment models, public, private, hybrid, and community clouds, Challenges and opportunities in cloud computing.

Unit II: Virtualization and Cloud Architecture **(7 Hours)**

Virtualization concepts and their importance in cloud environments. types of virtualization, hypervisors (Type 1 and Type 2), role of virtual machines and containers, cloud reference architecture, resource virtualization, management & essential cloud infrastructure components.

Unit III: Cloud Services and Storage **(7 Hours)**

Cloud service delivery mechanisms, various compute and storage services. Distributed storage systems, storage types object, block, and file storage. Content Delivery Networks (CDN), highlights security considerations in cloud storage.

Unit IV: Resource Management, Scalability & Security **(7 Hours)**

Techniques for resource provisioning and allocation in cloud systems, load balancing, auto-scaling, fault tolerance, and high availability, cloud security challenges, authentication and authorization mechanisms, issues related to data privacy and compliance.

Unit V: Cloud Platforms, Applications & Emerging Trends **(7 Hours)**

AWS Introduction, Azure Introduction,Google Cloud, serverless computing, Functions as a Service (FaaS). microservices architecture, container orchestration using Docker and Kubernetes, cloud monitoring tools, edge and fog computing, future trends in cloud computing.

Textbooks:

1. Rajkumar Buyya, James Broberg & Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley.
2. Barrie Sosinsky, Cloud Computing Bible, Wiley India Pvt. Ltd.
3. Anthony T. Velte, Toby J. Velte & Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw-Hill.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola & Thamarai Selvi, Mastering Cloud Computing, Tata McGraw Hill.
2. John W. Rittinghouse & James F. Ransome, Cloud Computing: Implementation, Management and Security, CRC Press.
3. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly.
4. Tim Mather, Subra Kumaraswamy & Shahed Latif, Cloud Security and Privacy, O'Reilly.

NPTEL Course:

Cloud Computing – Prof. Soumya Kanti Ghosh, IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc24_cs118/preview?utm_source=chatgpt.com