B. Tech. (Computer Engineering / Computer Science and Engineering / Computer Technology and Allied) Syllabus In Aligned with the National Education Policy 2020 Effective from AY 2025 - 2026 (All Years)

(Affiliated Colleges)

Note: Refer this Syllabus for Second Year in Computer Engineering / Computer Science and Engineering / Computer Technology / Computer Science and Engineering (Cyber Security) with branch codes 11242, 11245, 11251, 11260.

Department of Computer Engineering

Dr. Babasaheb Ambedkar Technological University, Lonere - 402103

www.cse.dbatu.ac.in

Semester - V

Teaching Scheme		Semester V Machine Learning	Examination Scheme	
TH	3	**Course Objectives:** 1. Understand core concepts and types of machine learning. 2. Apply supervised learning algorithms and handle overfitting. 3. Implement neural networks and basic deep learning models. 4. Explore probabilistic models and learning theory. 5. Use clustering and recommendation techniques for data analysis.	CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression, Decision trees, over fitting, Instance based learning, Feature reduction, Collaborative filtering based recommendation.	06 Hrs
2	Probability and Bayes learning, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM.	06 Hrs
3	Perceptron, multilayer network, back propagation, introduction to deep neural network.	06 Hrs
4	Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning.	06 Hrs
5	Clustering k-means, adaptive hierarchical clustering, Gaussian mixture model.	06 Hrs

Text / Reference Books:

1. Tom Mitchell, Machine Learning, First Edition, McGraw Hill, 1997.
2. Ethem Alpaydin, Introduction to Machine Learning, Prentice Hall India Learning Private Limited; 2nd edition, 2010.

Teaching Scheme		Semester V Theory of Computations	Examination Scheme	
TH	3	**Course Objectives:** 1. Learn the fundamentals of finite automata and their applications. 2. Understand regular expressions and grammars with their relation to automata. 3. Analyze context-free grammars and their simplification techniques. 4. Study pushdown automata and context-free language recognition. 5. Explore Turing machines, undecidability, and the Chomsky hierarchy.	CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	**Finite Automata (FA):** Introduction, Deterministic Finite Automata (DFA) -Formal definition, simpler notations (state transition diagram, transition table), language of a DFA. Nondeterministic Finite Automata (NFA)- Definition of NFA, language of an NFA, Equivalence of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Finite Automata with Epsilon Transitions, Eliminating Epsilon transitions, Minimization of Deterministic Finite Automata, Finite automata with output (Moore and Mealy machines) and Inter conversion.	08 Hrs
2	**Regular Expressions (RE):** Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions- Converting from DFA"s to Regular Expressions, Converting Regular Expressions to Automata, applications of Regular Expressions. **Regular Grammars:** Definition, regular grammars and FA, FA for regular grammar, Regular grammar for FA. Proving languages to be non-regular -Pumping lemma, applications, Closure properties of regular languages.	06 Hrs
3	**Context Free Grammar (CFG):** Derivation Trees, Sentential Forms, Rightmost and Leftmost derivations of Strings. Ambiguity in CFG"s, Minimization of CFG"s, CNF, GNF, Pumping Lemma for CFL"s, Enumeration of Properties of CFL (Proof"s omitted).	06 Hrs
4	**Pushdown Automata:** Definition, Model, Acceptance of CFL, Acceptance by Final State and Acceptance by Empty stack and its Equivalence, Equivalence of CFG and PDA. **Turing Machines (TM):** Formal definition and behaviour, Languages of a TM, TM as accepters and TM as a computer of integer functions, Types of TMs	08 Hrs
5	**Recursive And Recursively Enumerable Languages (REL):** Properties of recursive and recursively enumerable languages, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability, Post's correspondence problem (PCP), undecidability of PCP.	06 Hrs

Text / Reference Books:

1. Hopcroft, Ullman, Motwani, Introduction to Automata Theory, Languages, and Computation, Addison Wesley Publication, 2nd Edition, 2001.
2. Daniel I. A. Cohen, Introduction to Computer Theory, Wiley Publication, 1st Edition, 1986.
3. John C. Martin, Introduction to Languages and Theory of Computation, McGraw-Hill Publication, 4th Edition, 2010.
4. Krithivasan Kamala, Introduction to Formal Languages, Automata Theory and Computation, Pearson Education, 1st Edition, 2009.
5. Papadimitriou, Lewis, Elements of the Theory of Computations, PHI Publication, 2nd Edition, 1997.
6. E. V. Krishnamurthy, Introductory Theory of Computer Science, Springer-Velang New York Inc., 1st Edition, 1985.

Teaching Scheme		Semester V Operating Systems	Examination Scheme	
TH	3	**Course Objectives:** 1. Understand the structure, types, and components of operating systems, including system calls and virtual machines. 2. Learn process management, CPU scheduling algorithms, and multithreading models. 3. Analyze process synchronization, classical problems, and deadlock handling techniques. 4. Explore memory and virtual memory management, including paging and page replacement algorithms. 5. Study file systems, disk management, and mass-storage structures for efficient data handling.	CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	**Introduction and Operating system structures:** Definition, Types of Operating system, Real-Time operating system, System Components: System Services, Systems Calls, System Programs, System structure, Virtual Machines, System Design and Implementation, System Generations.	06 Hrs
2	**Processes and CPU Scheduling:** Process Concept, Process Scheduling, Operation on process, Inter-process Communication, Cooperating processes, Threads, Multithreading model, Scheduling criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Scheduling Algorithms evaluation.	06 Hrs
3	**Process Synchronization:** The critical-section problem, Critical regions, Peterson„s Solution, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.	08 Hrs
4	**Memory Management:** Basic concept, Logical and Physical address map, Memory allocation: Continuous Memory Allocation, Fixed and variable partition, Internal and external fragmentation and compaction, Paging: Principle of operation, Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging; Segmentation. **Virtual Memory:** Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page / Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).	08 Hrs
5	**File Management:** File Concept, Access methods, File types, File operation, Directory and disk structure, File System Structure, File System Implementation, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table),	06 Hrs

efficiency and performance. Mass-Storage Structure: Disk Structure, Disk attachment, Disk scheduling, Disk management, Swap Space Management.

Text / Reference Books:

1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, Wiley Publication, 8th Edition, 2008.
2. Andrew S. Tanenbaum, Modern Operating System, PHI Publication, 4th Edition, 2015.
3. D. M. Dhamdhere, Systems Programming and Operating Systems, McGraw-Hill, 2nd Edition, 1996.
4. Garry Nutt, Operating Systems Concepts, Pearson Publication, 3rd Edition, 2003.
5. Harvey M. Deitel, An Introduction to Operating Systems, Addison Wesley Publication, 2nd Edition, 1990.
6. Thomas W. Doeppner, Operating System in Depth: Design and Programming, Wiley Publication, 2011.

Teaching Scheme		Semester V Database Management Systems	Examination Scheme	
TH	3		CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	**Introduction:** Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management. **Database Architecture Data modeling using the Entity Relationship Model:** ER model concepts, notation for ER diagram, Constraints, keys, E-R Diagrams, Mapping Cardinality, Concepts of Super Key, candidate key, primary key, weak entity sets, Codd‘s rules, Extended ER model, Generalization, Aggregation, Reduction of an ER diagrams to tables.	08 Hrs
2	**Relational Data Model:** Structure of Relational Databases, Database Schema, Keys. **Relational algebra:** Fundamental Operations, Additional Relational Algebra Operations, Extended Relational Algebra Operations.	06 Hrs
3	**Calculus:** Tuple relational calculus, Domain relational Calculus, calculus vs. algebra, computational capabilities. **SQL:** Overview of SQL, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Modification of the Database.	08 Hrs
4	**Intermediate SQL:** Join Expressions, Views, Transactions, Integrity Constraints, SQL Data Types and Schema, Authorization. **Advanced SQL:** Assessing SQL from Programming Language, JDBC, ODBC, Embedded SQL, Functions and Procedures, Triggers,.	06 Hrs
5	**Normalization:** Features of good relational designs, Functional dependencies, Normal forms, First, Second, Third normal forms, BCNF, Functional Dependency Theory, Multivalued Dependencies, Fourth Normal Form, Database Design Process.	06 Hrs

Text / Reference Books:

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2011.
2. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill Publication, 3rd Edition, 2003.
3. Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates, 2nd Edition, 2014.
4. Wiederhold, Database Design, McGraw-Hill Publication, 2nd Edition, 1983.

5. Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
6. Mark L. Gillenson, Fundamentals of Database Management System, Wiley Publication, 2nd Edition, 2011.
7. Serge Abiteboul, Richard Hull, Victor Vianu, Foundations of Databases, Reprint by Addison-Wesley.

Teaching Scheme	Semester V Computer Graphics		Examination Scheme	
TH	3		CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	**Basic Concepts:** Introduction to computer graphics, lines, line segments, pixels and frame buffers, anti-aliasing techniques and character generation methods. Graphics Display devices (monochrome, color) interactive devices, Scanners and digitizers, touch panels, tablets, mouse, joysticks, trackball, light pen.	04 Hrs
2	**2D Transformation:** Line and circle plotting using Breshemham's and other algorithms, transformation matrices, scaling, rotation, translation, picture transformation, mirror image.	06 Hrs
3	**Window and Clipping:** Introduction, viewing transforms, 2-D clipping, Sutherland Cohen approach, Cyrus Beck Method, Midpoint subdivision algorithm, Liang-Barsky line clipping algorithm, polygon clipping, text clipping, generalized clipping.	06 Hrs
4	**3D Graphics:** Introduction, 3-D geometry, Coordination system, 3D transformation, rotation about an arbitrary axis, orthogonal projections, multiple views, isometric projection, perspective projections, 3-D clipping. **Hidden Surfaces and Lines:** Introduction, Back face removal algorithm, Z-buffers, Scan line and Painter's algorithm hidden surface removal, curved surface generation, generation of solids, sweep method, interpolation.	08 Hrs
5	**Graphical User Interface:** X-Windows, use of graphics tools like OPENGL, DirectX, Windows and Motif, Graphic Standards. **Animation:** Introduction, devices for producing animation, computer assisted animation, real time animation, method for controlling animation (fully explicit control, procedural).	06 Hrs

Text / Reference Books:

1. Peter Shirley, Michael Ashikhmin, Steve Marschner, Fundamental of Computer Graphics, 4^{th} Edition, CRC Press.
2. Newman, Sprouall, Interactive Computer Graphics, McGraw-Hill Publication.
3. Hearn, Baker, Computer Graphics, PHI Publication.
4. Krishnamurthy, Introduction to Computer Graphics, McGraw-Hill Publication.
5. ISRD Group, Computer Graphics, McGraw-Hill Publication.

Teaching Scheme		Semester V Introduction to Quantum Technologies	Examination Scheme	
TH	3		CA	20
PR	-		MSE	20
CR	3		ESE	60

COURSE CONTENT

Unit No.	Topic	Hours
1	**Foundations of Quantum Technologies:** Introduction, Evolution from Classical to Quantum Technologies, Classical Physics versus Quantum Physics, Fundamental Concepts of Quantum Mechanics, Wave–Particle Duality, Quantum States, Superposition Concept, Quantum Measurement, Quantum Coherence and Decoherence, Overview of the First and Second Quantum Revolution, Applications of Quantum Technologies.	05 Hrs
2	**Quantum Materials and Quantum Hardware:** Introduction, Semiconductor Materials for Quantum Devices, Superconducting Materials, Quantum Dots, Color Centers in Diamond, Trapped Ion Systems, Neutral Atom Platforms, Photonic Systems, Cryogenic Systems for Quantum Devices, Fabrication of Quantum Hardware, Challenges in Building Quantum Systems.	05 Hrs
3	**Quantum Communication and Quantum Networks:** Introduction, Classical versus Quantum Communication, Quantum Entanglement Concepts, Quantum Key Distribution (QKD), Quantum Random Number Generation, Quantum Repeaters, Quantum Internet Fundamentals, Quantum Communication Protocols, Secure Communication Applications, Challenges in Quantum Networking.	05 Hrs
4	**Quantum Sensing:** Introduction, Principles of Quantum Sensing, Atomic Clocks, Magnetometers, Gravimeters, Quantum Imaging, Quantum Metrology, Applications in Healthcare, Navigation, Aerospace, Defence, Environmental Monitoring, Industrial Measurement Systems, Emerging Trends in Quantum Sensing.	05 Hrs
5	**Quantum Technology Ecosystem:** Global Quantum Technology Landscape, National Quantum Mission of India, Quantum Research Infrastructure, Quantum Standards and Ethics, Commercial Quantum Technologies, Quantum Startups and Industrial Adoption, Workforce Development in Quantum Technologies, Challenges in Quantum Technology Deployment, Future Trends in Quantum Engineering, Case Studies of Real-World Quantum Applications.	05 Hrs

Text / Reference Books:

1. Bernhardt, C. (2019). Quantum computing for everyone. MIT Press.
2. Auffèves, A. (2022). Quantum technologies: Concepts and applications. ISTE Press–Elsevier.
3. Fox, M. (2006). Quantum optics: An introduction. Oxford University Press.

4. Griffiths, D. J., & Schroeter, D. F. (2018). Introduction to quantum mechanics (3rd ed.). Cambridge University Press.
5. Pirandola, S., & Braunstein, S. L. (Eds.). (2020). Quantum communications and cryptography. CRC Press.
6. National Quantum Mission Secretariat. (2024). National Quantum Mission: Vision and implementation framework. Government of India.

Teaching Scheme		Semester V Machine Learning Laboratory	Examination Scheme	
TH	-		CA	60
PR	2		MSE	-
CR	1		ESE	40

List of Experiments: (Perform any TEN Experiments)

1. Implement a toy classification problem using decision boundaries (manual coding). Apply train/test split and k-fold cross-validation to a dataset (e.g., Iris). Compare accuracy, precision, recall, F1-score.
2. Implement simple and multiple linear regression using NumPy and using scikit-learn. Plot regression lines and residuals. Compute RMSE and R^2 values.
3. Train a decision tree classifier and visualize the tree. Analyze performance with/without pruning and depth control. Demonstrate overfitting using synthetic data.
4. Implement and visualize k-Nearest Neighbors classification. Tune k and compare accuracy. Demonstrate curse of dimensionality.
5. Apply PCA and t-SNE for dimensionality reduction. Visualize high-dimensional data in 2D. Measure accuracy before and after feature reduction.
6. Implement a simple user-based and item-based collaborative filter. Use cosine similarity or Pearson correlation. Recommend top-N items for a user.
7. Implement Gaussian Naive Bayes manually and using scikit-learn. Classify spam/ham email or sentiment analysis.
8. Train logistic regression for binary classification. Visualize the sigmoid function and decision boundary. Analyze ROC curve and AUC.
9. Train a linear and kernel (RBF, polynomial) SVM. Visualize margins and support vectors. Tune C and gamma hyperparameters.
10. Implement a single-layer perceptron from scratch. Train a multilayer perceptron using scikit-learn / Keras. Compare performance with different activation functions.
11. Visualize layers, activations, and loss using Keras. Build a 2–3 layer DNN for digit classification.
12. Simulate sample complexity: How performance improves with increasing training size. Discuss PAC model using toy examples. Conceptual lab: VC Dimension estimation for linear classifiers.
13. Compare Bagging (Random Forest) vs Boosting (AdaBoost/XGBoost). Visualize feature importance.
14. Apply K-Means and visualize clusters. Use silhouette score and elbow method to tune K.
15. Fit a Gaussian Mixture Model (GMM) and visualize decision boundaries. Perform Agglomerative Clustering and plot dendrograms.

Teaching Scheme		Semester V Operating System Laboratory	Examination Scheme	
TH	-		CA	60
PR	2		MSE	-
CR	1		ESE	40

List of Experiments:

1. Hands on Unix Commands
2. Shell programming for file handling.
3. Shell Script programming using the commands grep, awk, and sed.
4. Implementation of various CPU scheduling algorithms (FCFS, SJF, Priority).
5. Implementation of various page replacement algorithms (FIFO, Optimal, LRU).
6. Concurrent programming; use of threads and processes, system calls (fork and v-fork).
7. Study pthreads and implement the following: Write a program which shows the performance.
8. Improvement in using threads as compared with process.(Examples like Matrix Multiplication.
9. Hyper Quick Sort, Merge sort, Traveling Sales Person problem).
10. Implementation of Synchronization primitives – Semaphore, Locks and Conditional Variables.
11. Implementation of Producer-Consumer problem, Bankers algorithm.
12. Implementation of various memory allocation algorithms, (First fit, Best fit and Worst fit), Disk.
13. Scheduling algorithms (FCFS, SCAN, SSTF, C-SCAN).
14. Kernel reconfiguration, device drivers and systems administration of different operating systems.
15. Writing utilities and OS performance tuning.

Teaching Scheme		**Semester V Database Management System Laboratory**	**Examination Scheme**	
TH	-		CA	60
PR	2		MSE	-
CR	1		ESE	40

List of Experiments:

1. Defining schema for applications.
2. Creating tables, Renaming tables, Data constraints (Primary key, Foreign key, Not Null), Data insertion into a table.
3. Grouping data, aggregate functions, Oracle functions (mathematical, character functions).
4. Assignment on Sub-queries, Set operations, Joins.
5. Creation of databases, writing SQL and PL/SQL queries to retrieve information from the databases.
6. Assignment on Triggers & Cursors.
7. Normal Forms: First, Second, Third and Boyce Codd Normal Forms.
8. Assignment in Design and Implementation of Database systems or packages for applications such as office automation, hotel management, hospital management.
9. Deployment of Forms, Reports Normalization, Query Processing Algorithms in the above application project.
10. Assignment on Large objects – CLOB, NCLOB, BLOB and BFILE.
11. Creating web-page interfaces for database applications using servlet.

Teaching Scheme		**Semester V** **Seminar**	**Examination Scheme**	
TH	-		CA	60
PR	2		MSE	-
CR	1		ESE	40

<u>Guidelines for Seminar</u>

The students shall study in group of two members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Computer Science Engineering, Artificial Intelligence, Data Science, or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher. The students shall prepare his report and deliver talk on the topic for other students of his class in the presence of his guide and internal examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

<u>Continues Assessment:</u> The Continues Assessment for this head will consists of the report written in a technical reporting manner and presentation of the talk on the subject and will be assessed by the internal examiner appointed by the Head of concern department of the institution.

B.Tech in Computer Engineering and Allied Programs
Course Curriculum Aligned with National Education Policy 2020
(Effective from Academic Year 2026 - 2027)
Fifth Semester

Course Categories	Course Code	Course Name	Weekly Hours		Examination Scheme			Credit
			L	P	CA	MSE	ESE	
PCC1	26AF1245PC501	Machine Learning	3	-	20	20	60	3
PCC2	26AF1245PC502	Theory of Computations	3	-	20	20	60	3
PCC3	26AF1245PC503	Operating Systems	3	-	20	20	60	3
PCC4	26AF1245PC504	Database Management Systems	3	-	20	20	60	3
PEC	26AF1XXXOEM05X	**Open Elective Bucket**	2	-	20	20	60	2
MDM	26AF1245MD506	**MDM Bucket***	-	-	20	20	60	-
OE-3	26AF1245PE507	**Program Elective** A. Computer Graphics B. Introduction to Quantum Technologies	3	-	20	20	60	3
PCC Lab	26AF1245PCL508	Machine Learning Laboratory	-	2	60	-	40	1
PCC Lab	26AF1245PCL509	Operating System Laboratory	-	2	60	-	40	1
PCC Lab	26AF1245PCL510	Database Management System Laboratory	-	2	60	-	40	1
AEC	26AF1245AE511	Seminar	-	2	60	-	40	1
		Total	**17**	**8**	**380**	**140**	**580**	**21**

**A student must select a course or courses from the minor degree program s/he wishes to pursue.*
A student must select a course from the list of open elective courses attached to the Open Elective (OE) Bucket.