Curriculum and Syllabus

[Regulation–25]

Master of Technology (M.Tech.)
in
Computer Science and Engineering

(Effective From 2025–2026 Admission Batch)

Department of Computer Science and Engineering
Narula Institute of Technology

NBA Accredited Department
NAAC 'A' Accredited Autonomous Institute

Affiliated to Maulana Abul Kalam Azad University of Technology
Formerly known as West Bengal University of Technology

West Bengal, India

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

1st Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Theory				L T P	Total	
1	Core	CSM101	Mathematical Foundations of Computer Science	3-0-0	3	3
2	Core	CSM102	Advanced Data Structures and Algorithms	3-0-0	3	3
3	Core	CSM103	Advanced Operating System	3-0-0	3	3
4	Elective I	CSM104A CSM104B CSM104C CSM104D	Wireless Sensor Network Statistics for Computer Science Digital Image Processing Advanced Soft Computing	3-0-0	3	3
5	Elective II	CSM105A CSM105B CSM105C CSM105D	Advanced Mobile Computing Optimization Techniques Computer Vision Quantum Computing	3-0-0	3	3
6	MLC	CSM106	Research Methodology and IPR	3-0-0	3	3
B. Practical						
7	Core	CSM192	Advanced Data Structures and Algorithms Lab	0-0-3	3	1.5
8	Core	CSM193	Advanced Operating System Lab	0-0-3	3	1.5
Total				**18-0-6**	**24**	**21**

**MLC: Mandatory Learning Course*

***L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]*

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2nd Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Theory				L T P	Total	
1	Core	CSM201	Advanced Database Management System	3-0-0	3	3
2	Core	CSM202	Data Science and Visualization	3-0-0	3	3
3	Elective III	CSM203A CSM203B CSM203C CSM203D	Internet of Things Advanced Machine Learning Digital Signal Processing High Performance Computing	3-0-0	3	3
4	Elective IV	CSM204A CSM204B CSM204C CSM204D	Blockchain and Cyber Security Natural Language Processing and Large Language Model Pattern Recognition Cloud Computing	3-0-0	3	3
B. Sessional						
5	Audit I	CSM206	**Audit Course-I:** 1. English for Research Paper Writing 2. Disaster Management 3. Sanskrit for Technical Knowledge 4. Value Education	2-0-0	2	0
C. Practical						
6	Core	CSM291	Advanced Database Management System Lab	0-0-3	3	1.5
7	Core	CSM292	Data Science and Visualization Lab	0-0-3	3	1.5
8	Project	CSM281	Mini Project with Seminar	0-0-4	4	2
Total				**14-0-10**	**24**	**17**

****L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]***

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3rd Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Sessional				L T P	Total	
1	Audit-II	CSM301	**Audit Course-II:** 1. Constitution of India 2. Pedagogy Studies 3. Stress Management by Yoga 4. Personality Development through Life Enlightenment Skills	2-0-0	2	0
B. Practical						
2	Project	CSM391	Dissertation-I / Industry Internship	0-0-20	20	10
Total				**2-0-20**	**22**	**10**

L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]

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4th Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Practical				L T P	Total	
1	Skill	CSM491	Comprehensive Viva Voce	0-0-0	0	4
2	Project	CSM492	Dissertation-II / Industry Internship	0-0-32	32	16
Total				**0-0-32**	**32**	**20**

Total Credit: 68

****L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]***

R-25 Curriculum for Master of Technology (M.Tech)

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Narula Institute of Technology

1st Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Theory				L T P	Total	
1	Core	CSM101	Mathematical Foundations of Computer Science	3-0-0	3	3
2	Core	CSM102	Advanced Data Structures and Algorithms	3-0-0	3	3
3	Core	CSM103	Advanced Operating System	3-0-0	3	3
4	Elective I	CSM104A CSM104B CSM104C CSM104D	Wireless Sensor Network Statistics for Computer Science Digital Image Processing Advanced Soft Computing	3-0-0	3	3
5	Elective II	CSM105A CSM105B CSM105C CSM105D	Advanced Mobile Computing Optimization Techniques Computer Vision Quantum Computing	3-0-0	3	3
6	MLC	CSM106	Research Methodology and IPR	3-0-0	3	3
B. Practical						
7	Core	CSM192	Advanced Data Structures and Algorithms Lab	0-0-3	3	1.5
8	Core	CSM193	Advanced Operating System Lab	0-0-3	3	1.5
Total				**18-0-6**	**24**	**21**

**MLC: Mandatory Learning Course*

***L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]*

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Mathematical Foundations of Computer Science
Course Code: CSM101
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: UG Level Mathematics, Discrete Mathematics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the basic concepts of combinatorics and probability to **Explain or Illustrate and Identify** problems where students can **Apply** the concept appropriately to Solve them.
CO2	**Understand** and **Explain** the fundamental concepts of statistical inference, and sampling distributions and Identify the scope of its application where students can **Apply** the appropriate strategy and **Analyze** the results.
CO3	**Understand** and **Explain** the fundamental concepts of graph theory and number theory and **Identify** the scope of its application where students can **Apply** the appropriate strategy and **Analyze** the results.
CO4	**Understand** and **Explain** the fundamental concepts of Calculus of Several Variables and algebraic structures and **Identify** the scope of its application where students can **Apply** the appropriate strategy and **Analyze** the results.
CO5	**Understand** and **Develop** ideas to **Propose** mathematical models to solve the problems and **Analyze** the effectiveness as well as limitations of solutions underscoring its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module 1: Combinatorics and counting [2L]:

Sum and product rule, Permutation and Combination Principle of Inclusion Exclusion. Pigeon Hole Principle.

Module 2: Graph Theory [5L]:

Graph Terminologies and their properties: Degree, Connectivity, Path, Cycle, SubGraph, Isomorphism, Eulerian and Hamiltonian Walks, Matrix representation of graphs.
Graph Colouring and Matching: Colouring Vertices and Chromatic Number, Colouring Edges and Total Colouring, Independence and Chromatic Partitioning, Cliques, Perfect Graphs, Bounds on Chromatic Numbers, Chromatic Polynomials.

Module 3: Algebraic Structures [3L]:

Group, Ring, Field; Linear Algebra: Systems of Linear Equations and Matrices, Vector Space, Linear Transformations, Eigen values & Eigen Vectors.

Module 4: Number Theory [3L]:

Primes, Divisibility and the Fundamental Theorem of Arithmetic; Greatest Common Divisor (GCD), Euclidean Algorithm; Congruences, Chinese Remainder Hensel's Lemma, Primitive Roots; Quadratic Residues and Reciprocity; Arithmetic Functions, Diophantine Equations, Continued Fractions.

Module 5: Calculus of Several Variables [3L]:

Differential Calculus of Several Variables, Integral Calculus of Several Variables, Fundamental Theorems of Vector Calculus.

Module 6: Descriptive Statistics [3L]:

Measures of Central Tendency, Measures of Dispersion, Skewness and Kurtosis, Correlation, Linear Regression Analysis, Index Numbers, Time Series Analysis; Basics of Probability: Axiomatic Probability, Conditional Probability, Bayes' Theorem, Random Variables and Mathematical Expectations.

Module 7: Distributions [5L]:

Continuous Distributions - normal distribution, standard normal distribution, tdistribution, chi-square distribution, F-distribution, Discrete Distributions: Binomial distribution, Poisson distribution, Principles of Sampling, Types of Sampling, Unbiased and Consistent estimators, Point Estimation, Maximum Likelihood Estimation of parameters-Binomial, Poisson and Normal, Interval estimation.

Module 8: Hypothesis Testing [7L]:

Simple & Composite hypothesis, Tests of Significance, Null Hypothesis, Alternative Hypothesis, Types of Errors in Testing Hypothesis, Level of Significance, Critical Region, One-Tailed and Two-Tailed Tests, Different Hypothesis Testing: Population mean, population Variance, ratio of two population variances, difference between two population means, population proportion, difference between two proportions. Application of Chi-Square Distribution in testing goodness of fit.

Module 9: [6L]:

Analysis of Variance (ANOVA), One-Way Classification, Two-Way Classification Markov Model, Basic Concept of Markov Model and Hidden Markov Model and related applications; Statistical Decision Analysis: Decision making under Risk, Decision making under Conflict.

Text Books:

1. John Vince, Foundation Mathematics for Computer Science, Springer
2. Susanna S. Epp, Discrete Mathematics with Applications, 4th edition, Wadsworth Publishing Co. Inc.
3. Applied Statistics and Probability for Engineers; Douglas C. Montogomery and George C. Runger; Wiley
4. Serge Lang, Calculus of Several Variables, Springer-Verlag New York

Reference Books:

1. M. Mitzenmacher and E. Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis
2. Alan Tucker, Applied Combinatorics, Wiley
3. K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
4. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
5. Data analysis using statistics and probability with R language; Partha Sarathi Bishnu and Vandana Bhattacherjee; PHI Learning

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	2	2
CO2	3	2	2	3	2
CO3	3	3	2	3	2
CO4	2	3	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Data Structures and Algorithms**
Course Code: **CSM102**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: UG-level Data Structures, Algorithms, and Discrete Mathematics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand and analyze** advanced data structures for solving complex computational problems.
CO2	**Apply** algorithmic paradigms and techniques for efficient problem solving.
CO3	**Evaluate** performance of algorithms using asymptotic analysis, amortized analysis, and probabilistic methods.
CO4	**Design and implement** algorithms for optimization, graph-based, and real-world applications.
CO5	Critically **analyze and compare** different algorithmic approaches and develop research-level insights.

Course Content:

Module 1: Algorithm Analysis [4L]:

Review of asymptotic notations, recurrence relations (Master Theorem, Iteration method, Substitution), Amortized analysis (aggregate, accounting, potential methods), Randomized algorithms and probabilistic analysis.

Module 2: Advanced Data Structures [6L]:

Balanced Trees: AVL Trees, Red-Black Trees, Splay Trees, B-Trees, B+ Trees, Skip Lists and Treaps, Advanced Heaps: Binomial Heaps, Fibonacci Heaps, Pairing Heaps, Union-Find/Disjoint Sets with path compression and union by rank.

Module 3: Graph Algorithms [6L]:

Advanced shortest path algorithms (Johnson's, Dijkstra with Fibonacci heaps), Maximum Flow and Minimum Cut (Ford-Fulkerson, Edmonds-Karp, Push-Relabel), Matching and Covering in Bipartite Graphs (Hungarian Algorithm, Hopcroft–Karp), Applications in networks and real-world case studies.

Module 4: String, Pattern Matching & Computational Geometry [5L]:

Suffix Trees, Suffix Arrays, LCP arrays, KMP, Rabin–Karp, Boyer–Moore algorithms, Tries, Aho–Corasick Automaton, Convex Hull algorithms (Graham's Scan, Jarvis's March), Line segment intersection, Voronoi diagrams (introductory).

Module 5: Advanced Algorithmic Techniques [5L]:
Dynamic Programming optimizations (Knuth, Divide & Conquer DP, Bitmask DP), Greedy strategies with proofs of correctness, Backtracking and Branch & Bound, Approximation algorithms for NP-hard problems.

Module 6: Parallel and External Memory Algorithms [5L]:
PRAM model and parallel algorithms for searching and sorting, External memory algorithms (cache-aware, cache-oblivious), Introduction to streaming algorithms and sublinear time algorithms.

Module 7: Recent Trends [5L]:
Introduction to Quantum algorithms (Grover's, Shor's – overview only), Graph Neural Networks and algorithmic learning, Applications in big data, bioinformatics, and computational sustainability.

Text Books:

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein – Introduction to Algorithms, MIT Press.
2. M. Goodrich, R. Tamassia – Algorithm Design and Applications, Wiley.
3. S. Sahni – Data Structures, Algorithms and Applications in C++.

Reference Books:

1. R. Motwani, P. Raghavan – Randomized Algorithms.
2. D. Gusfield – Algorithms on Strings, Trees and Sequences.
3. K. Mehlhorn, P. Sanders – Algorithms and Data Structures: The Basic Toolbox.
4. U. Manber – Introduction to Algorithms: A Creative Approach.
5. J. Kleinberg, É. Tardos – Algorithm Design.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	3	2	2	3
CO4	3	2	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Operating System**
Course Code: **CSM103**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: UG-level Operating Systems (processes, memory, file system basics), Computer Architecture fundamentals

Course Outcome(s): After completion of the course students will be able to

CO1	**Compare and analyze** advanced OS architectures and kernel models.
CO2	**Evaluate** scheduling and resource management policies for multicore and real-time systems.
CO3	**Apply** advanced memory management and virtualization techniques in system design.
CO4	**Explain and implement** principles of distributed operating systems including synchronization, file systems, and consensus.
CO5	Critically **Analyze** OS security, real-time requirements, and emerging trends such as cloud and edge OS.

Course Content:

Module 1: OS Structures & Process Management [5L]:

Advanced OS architectures: monolithic, microkernel, hybrid, System calls, kernel/user mode, kernel structures, Advanced process/thread models, multicore/multithread scheduling, Synchronization: locks, semaphores, monitors, lock-free & wait-free algorithms.

Module 2: Advanced Scheduling & Resource Management [6L]:

Multiprocessor & multicore scheduling: load balancing, affinity, fairness, Real-time scheduling: EDF, Rate Monotonic, priority inversion handling, Resource allocation strategies, deadlock detection and recovery.

Module 3: Memory Management & Virtualization [6L]:

Advanced virtual memory, paging, huge pages, NUMA issues, Kernel memory allocation, cache and buffer management, Virtualization: full/para-virtualization, hypervisors, nested virtualization, Containerization and OS-level virtualization.

Module 4: File Systems, Storage & I/O Systems [6L]:

Modern file systems: journaling, log-structured, copy-on-write (Btrfs/ZFS), Distributed file systems: NFS, AFS, GFS, HDFS concepts, I/O subsystems: asynchronous I/O, storage stack, NVMe, Fault tolerance, checkpointing and recovery.

Module 5: Distributed Operating Systems [7L]:

Distributed system architectures, transparency issues, Distributed synchronization: clocks, event ordering, mutual exclusion, Distributed resource management, deadlock detection,

Consensus protocols (Paxos, Raft), Case studies: Amoeba, Mach, modern cloud OS components.

Module 6: Security, Real-time & Emerging OS Trends [6L]:
Security: protection models (ACL, capability), secure boot, kernel hardening, Real-time & embedded OS design, interrupt latency, RTOS case studies, OS support for cloud, data centers, edge/IoT systems, Research trends: OS for AI/ML workloads, energy-aware OS design.

Text Books:

1. A. S. Tanenbaum & H. Bos – Modern Operating Systems (4th Ed.).
2. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne – Operating System Concepts (9th Ed.).
3. William Stallings – Operating Systems: Internals and Design Principles.

Reference Books:

1. A. S. Tanenbaum – Distributed Operating Systems.
2. Coulouris, Dollimore, Kindberg – Distributed Systems: Concepts and Design.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Wireless Sensor Networks**
Course Code: **CSM104A**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: UG Level Computer Network and programming

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the basic concepts of WSN to **Explain or Illustrate and Identify** problems where students can Apply the concept appropriately to Solve them.
CO2	**Understand** the fundamental concepts of WSN-MAC Layer so that they can propose models for predicting values based on exemplary data and **Analyze** their performances.
CO3	**Explain or Illustrate** the fundamental strategies of WSN-Security to solve clustering problems and **Analyze** their performances.
CO4	**Explain** the concepts of WSN-Routing Protocols and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to Propose solutions to the problems of WSN and **Identify** problems where students can **Apply** the advanced concept appropriately and Analyze the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module 1: Fundamentals of wireless communication technology and sensor network [8L]:

the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet. Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering. Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture Hardware Platforms: Motes, Hardware parameters

Module 2: Medium Access Control Protocol [8L]:

Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis MAC Protocol Analysis: Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).

Module 3: Data Dissemination, Aggregation,Security [4L]:

Data-centric approaches: aggregation, fusion, data-centric storage, in-network processing., Possible attacks, countermeasures, SPINS, Static and dynamic key distribution

Module 4: Routing Protocol [5L]:

Routing protocols: Introduction, MANET protocols Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast Opportunistic Routing Analysis: Analysis of opportunistic routing (Markov Chain)

Module 5: Localization, Synchronization & Coverage[5L]:
Localization methods: single-hop and multi-hop, anchor-based, Time synchronization: sender-to-receiver vs receiver-to-receiver methods, Coverage and topology management: algorithms for coverage optimization, sleep cycles, topology control.

Module 6: Simulations, Case Studies & Emerging Applications[6L]:
WSN deployment tools: simulation frameworks like Cooja, TelosB, etc, Real-world case examples: smart agriculture, environmental monitoring, healthcare, IoT integration: edge computing, cloud interfaces, data analytics pipelines.

Text Books:

1. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010.
2. Kazemv Sohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley 2007.
3. Holger Karl & Andreas Willig — Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005.

Reference Books:

1. Takahiro Hara, Vladimir I. Zadorozhny, and Erik Buchmann, "Wireless Sensor Network Technologies for the Information Explosion Era", Springer.
2. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless networks ", Pearson Education - 2008.
3. Operating Systems: TinyOS/nesC tutorials (Philip Levis' courses).

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	2	3	2	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Statistics for Computer Science
Course Code: CSM104B
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Undergraduate-level Probability and Statistics, Discrete Mathematics

Course Outcome(s): After completion of the course students will be able to

CO1	**Apply** probability theory and common statistical distributions to model computing scenarios.
CO2	**Apply** statistical inference including estimation, hypothesis testing, and interpret results correctly.
CO3	**Implement and analyze** linear (and logistic) regression models, understanding trade-offs like bias–variance.
CO4	**Explain** dimensionality reduction and classification techniques for pattern recognition and data preprocessing.
CO5	**Leverage** computational methods—simulation, resampling, visualization—for data-driven problem solving in computer science.

Course Content:

Module 1: Foundations of Probability & Statistical Distributions [6L]:

Random variables, expectation, variance, Common discrete and continuous distributions (Bernoulli, Binomial, Poisson, Uniform, Gaussian), Central Limit Theorem, Law of Large Numbers

Module 2: Statistical Inference & Hypothesis Testing [6L]:

Point and interval estimation: MLE and Bayesian estimation, Hypothesis testing: z-test, t-test, chi-squared test, p-values, errors, Confidence intervals and sample size considerations

Module 3: Linear Models & Regression Analysis [6L]:

Simple and multiple linear regression, Estimation techniques and interpretation (R^2, significance tests), Bias–variance trade-off; introduction to logistic regression and classification concepts

Module 4: Dimensionality Reduction & Multivariate Techniques [6L]:

Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Introduction to LDA and feature extraction techniques, Handling high-dimensional data in computer science contexts

Module 5: Statistical Learning & Classification Methods [6L]:

Bayes classifier, LDA, QDA, k-Nearest Neighbors, ensemble methods (bagging, boosting), Model evaluation: accuracy, precision/recall, ROC curves

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Module 6: Computational Methods & Simulation Techniques [6L]:
Resampling methods: Bootstrap, cross-validation, Monte Carlo simulation basics, Statistical computing tools (R/Python libraries) and data visualization

Text Books:

1. John A. Rice — Mathematical Statistics and Data Analysis (strong foundation in theory with applications)
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman — The Elements of Statistical Learning (excellent for regression, classification, high-dimensional methods)
3. Christopher Bishop — Pattern Recognition and Machine Learning (comprehensive coverage of Bayesian methods and classifiers)

Reference Books:

1. Rohatgi & Saleh — An Introduction to Probability and Statistics (clear exposition suitable for engineers)
2. Montgomery & Runger — Applied Statistics and Probability for Engineers (practical examples)—complementary
3. Online resources: R/Python libraries (scikit-learn, pandas), with simulation and visualization code examples

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	2	3	3	3
CO5	3	1	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Digital Image Processing**
Course Code: **CSM104C**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Knowledge of Linear Algebra, Probability and Statistics, Signal Processing, and Programming in Python/Matlab.

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** fundamental concepts of digital images, image formation, representation, and basic transformations.
CO2	**Apply** image enhancement and restoration techniques in both spatial and frequency domains.
CO3	**Analyze** image segmentation, morphological processing, and feature extraction techniques.
CO4	**Design and Implement** algorithms for image compression, representation, and recognition.
CO5	**Evaluate** real-world applications of image processing in medical imaging, remote sensing, and computer vision.

Course Content:

Module 1: Introduction to Digital Image Processing [6L]:

Elements of a digital image processing system, image sampling and quantization, image representation, image models, basic relationships between pixels, imaging sensors, and basic transformations.

Module 2: Image Enhancement & Restoration [8L]:

Spatial domain techniques: point processing, histogram processing, spatial filtering; Frequency domain techniques: Fourier transform, image smoothing and sharpening, homomorphic filtering; Image degradation model, restoration by inverse and Wiener filtering.

Module 3: Image Segmentation & Morphological Processing [7L]:

Edge detection, thresholding, region-based segmentation, watershed segmentation; Dilation, erosion, opening, closing, hit-or-miss transformation, applications of morphology.

Module 4: Image Compression & Representation [7L]:

Compression models, lossless and lossy compression techniques, predictive coding, transform coding, JPEG, JPEG2000, wavelet-based compression, representation and description, boundary descriptors, regional descriptors.

Module 5: Applications of Image Processing [8L]:

Case studies in medical imaging, remote sensing, industrial inspection, biometrics, pattern recognition, and computer vision applications. Introduction to recent trends: deep learning in image analysis.

Text Books:

1. Digital Image Processing. Rafael C. Gonza Lez and Richard E. Woods. ISBN: 9353062985. Pearson Education.
2. Introductory Digital Image Processing: A Remote Sensing Perspective. ISBN: 9352864352. Pearson Education.
3. DIGITAL IMAGE PROCESSING. S Sridhar. ISBN: 0199459355. Oxford Publisher.

Reference Books:

1. DIGITAL IMAGE PROCESSING. S Jayaraman, S Esakkirajan, T Veerakumar. ISBN: 9389811929. McGraw Hill.
2. Digital Image Processing and Analysis. Chanda. ISBN: 9788120343252. PHI Publisher.
3. Digital Image Processing Using Python: A comprehensive guide to the fundamentals of digital image processing. Manish Kashyap. ISBN: 9365898919. BPB Publisher.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	2	1
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Soft Computing**
Course Code: **CSM104D**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Discrete Mathematics, Probability and Statistics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** and **Explain** the basic concept of soft computing and hard computing and **Apply** them in designing solution to engineering problem.
CO2	**Understand** and **Explain** appropriate ANN learning rules for each of the architectures and learn soft computing paradigms and apply the rules to **Solve** engineering and other problems.
CO3	**Understand** and **Explain** the concept of rough set and **Apply** the concept to solve engineering and other problems.
CO4	**Apply** fuzzy logic and reasoning to handle uncertainty and solving interdisciplinary engineering problems
CO5	**Design** and implement GA, PSO and ACO algorithms for optimization problems in Engineering problem

Course Content:

Module 1: Introduction to Soft Computing: [9L]:

An Overview of Artificial Intelligence, Evolution of Computing - Soft Computing Constituents – From Conventional Artificial Intelligence to Computational Intelligence - Machine Learning Basics. Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.
Artificial Neural Network: Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications.

Module 2: Fuzzy sets and Fuzzy logic [9L]:

Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables.
Fuzzy logic, Linguistic hedges, Applications, fuzzy Controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.

Module 3: Evolutionary algorithms [4L]:

A History of Evolutionary Computation, Introduction to Evolutionary Algorithms Evolutional Strategies, Evolutionary Programming, Different Components of Evolutionary Algorithms. Experimental (statistical) Methods for the analysis of Evolutionary Algorithms: Theoretical Analysis of Evolutionary Algorithms, Interactive Evolutionary Algorithms, Experiment design and analysis involving Evolutionary Algorithms.

Module 4: Genetic Algorithms & Rough Set [9L]:

Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications.
Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Module 5: Swarm Intelligence Algorithms [5L]:
Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Differential Evolution (DE), Artificial Bee Colony (ABC) and Cuckoo Search Algorithms (CSA), Applications. Latest Developments in Nature Inspired Algorithms.

Text Books:

1. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran & G. A. V. Pai, PHI.
2. Principles of Soft Computing, S.N. Sivanandam, S.N Deepa, wiley publications.
3. A. E. Eiben and J. E. Smith, An Introduction to Evolutionary Computing, Natural Computing Series, Springer, 2nd Edition, 2015.
4. An Introduction to Genetic Algorithm, Mitchell Melanie, Prentice Hall, 1998.

Reference Books:

1. Genetic Algorithms in Search, Optimization and Machine Learning, David E. Goldberg, Addison Wesley, 1997.
2. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
3. Soft Computing with MATLAB Programming, N. P. Padhy and S. P. Simon, Oxford University Press; UK ed. edition.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	3	2
CO2	2	3	2	3	2
CO3	3	3	2	2	3
CO4	3	2	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Advanced Mobile Computing
Course Code: CSM105A
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: UG Level Computer Networks, Operating system and programming

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** GSM, GPRS, and LTE architectures and mobility management concepts.
CO2	**Analyze** mobile communication protocols (MAC, routing, transport) and localization techniques.
CO3	**Design** distributed algorithms and middleware for mobile/ad-hoc environments and **Develop** mobile applications using advanced OS and platform features.
CO4	**Apply** cloud/edge paradigms for mobile offloading and pervasive computing.
CO5	**Evaluate** mobile security frameworks and future research trends like 6G and federated learning.

Course Content:

Module 1: Foundations of Mobile Computing [2L]:

Evolution of mobile communications, Characteristics: portability, mobility, context awareness, Mobile computing vs pervasive/ubiquitous computing, Applications: mHealth, mobile commerce, vehicular systems.

Module 2: GSM Architecture & Mobile Systems [7L]:

GSM system architecture: MS, BTS, BSC, MSC, HLR, VLR, AuC, EIR, Call setup and handoff procedures, GPRS architecture: SGSN, GGSN, tunneling, UMTS and LTE overview: packet-switched core, IMS, Localization in GSM/UMTS: Cell-ID, triangulation, TOA, AOA, GPS-assisted.

Module 3: Communication & Networking Protocols [6L]:

Physical/MAC layer: FDMA, TDMA, CDMA, OFDMA, Cellular concepts: frequency reuse, handoff types, Mobile IP, mobility management protocols, Transport layer in mobile: Indirect TCP, Snooping TCP, Freeze TCP.

Module 4: Ad Hoc, Sensor & Vehicular Networks [5L]:

MANETs: routing challenges under mobility, Routing protocols: AODV, DSR, OLSR, ZRP, VANET protocols: V2V, V2I communication, WSN–IoT integration with mobile networks.

Module 5: Middleware & Distributed Algorithms [5L]:
Mobile middleware and service discovery, Distributed algorithms for mobile environments: Synchronization and mutual exclusion, Replication, caching, Checkpointing and recovery, Publish/subscribe in mobile computing.

Module 6: Mobile OS & Application Platforms [6L]:
Mobile OS: Android, iOS, KaiOS — architecture and process lifecycle, Energy management and scheduling, Mobile application frameworks, APIs, SDKs, Location-based services (GPS, hybrid localization).

Module 7: Mobile Cloud & Edge Computing, Security [5L]:
Mobile cloud concepts: offloading, cloudlets, fog, edge computing, Latency-aware application design, Mobile Big Data analytics and federated learning, Case studies: Smart city, mHealth, AR/VR, Authentication, authorization, mobile payment security, Privacy-preserving mobile applications.

Text Books:

1. Jochen Schiller – Mobile Communications, Pearson.
2. Raj Kamal – Mobile Computing, McGraw-Hill.
3. Asoke K. Talukder & Roopa Yavagal – Mobile Computing: Technology, Applications and Service Creation, McGraw-Hill.

Reference Books:

1. Ivan Stojmenovic – Handbook of Wireless Networks and Mobile Computing, Wiley.
2. Theodore S. Rappaport – Wireless Communications: Principles and Practice, Prentice Hall.
3. George Coulouris et al. – Distributed Systems: Concepts and Design.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	2
CO5	3	2	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Optimization Techniques**
Course Code: **CSM105B**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Linear Algebra and Numerical Methods

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** and **Explain** the importance of Optimization Algorithms
CO2	**Acquire** in depth knowledge of Optimization with equality constraint and **Apply** it to solve problems.
CO3	**Understand** and **Explain** Optimization with inequality constraint and **Apply** it to **Solve** problems.
CO4	**Understand** the basic concepts of nature inspired optimization algorithms to **Explain** or **Illustrate** and **Apply** the concept appropriately.
CO5	**Understand** the advanced concepts of Optimization Algorithms to **Apply** the concept appropriately it to solve problems.

Course Content:

Module 1: **Introduction [5L]:**

Optimization Algorithms, Constraints, The Feasible Region.

Module 2: **Optimization with equality constraint: [5L]:**

Optimization using calculus, Graphical Optimization, Lagrange's method of undetermined multiplier and applications

Module 3: **Optimization with inequality constraint [7L]:**

Non-linear Programming problem- Quadratic Programming, Semi Definite Programming with applications, Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module 4: **Various Optimization Algorithm [6L]:**

Discuss about various optimization algorithms viz. Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.

Module 5: **Applications [12L]:**
Applications of G.A, P.S.O and ACO in global optimization problems. Applications in Biological sequence comparison.

Text Books:

1. Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India.
2. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
3. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).
4. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004)

Reference Books:

1. Kenneth J. Knapp, "Cyber Security and Global Information Assurance: Threat Analysis and Response Solutions", IGI Global, 2009.
2. Jonathan Rosenoer, "Cyber law: the Law of the Internet", Springer verlag, 1997
3. Vasu Deva, Cyber Crimes and Law Enforcement, Commonwealth Publishers, New Delhi, (2003) .

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	2	2
CO2	3	2	2	3	2
CO3	3	2	2	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Computer Vision
Course Code: CSM105C
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Digital Image Processing, Machine Learning

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the basic concepts of Computer Vision to **Explain** or **Illustrate** and Identify problems where students can Apply the concept appropriately to Solve them
CO2	**Understand** the fundamental concepts of Image Analysis and Image Feature Descriptors, and Extraction Techniques and **Analyze** their performances.
CO3	**Explain** or **Illustrate** the fundamental strategies of Image Registration to **solve** related problems and Analyze their performances
CO4	**Explain** or **Illustrate** the concepts of Shape Matching, Video Processing and Apply them to solve the relevant problems and **Analyse** their performances
CO5	**Develop** ideas to **Propose** solutions to the problems of Computer Vision and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module 1: Introduction to Computer Vision [2L]:

Basics of Computer Vision Systems, Computer Vision Problems, Computer Vision Solution Models.

Module 2: Image Analysis and Image Feature Descriptors [12L]:

Image Analysis Basics, Edge Detection and Hough Transform – Definition Edges, Edges in real image, Gradient, Steps in Edge Detection, Different Edge Detectors, Second Derivative Operators, Laplacian Operator, Laplacian of Gaussian, Canny Edge Detector, Hough Transform, Hough space, Finding Circles by Hough Transform, Generalized Hough Transform.
Image Feature Descriptors and Extraction Techniques – Image Object Shape Descriptors, HOG, Harris Corner Detector, Scale Invariant Feature Transform (SIFT), SIFT-PCA, Speeded Up Robust Features (SURF).

Module 3: Texture Analysis [6L]:

Definition and Applications, Texture Definition - Statistical Approach, Edge Density and Direction, Local Binary Pattern, Gray Level Co-occurance Matrix, Co-occurrence Features, Laws' Texture Energy Features, Law's texture masks, LBP: Applications to Medical Images.

Module 4: Image Registration [4L]:

Transformation, Registration algorithms - Point-based Method, Landmark based Method, Intensity based Method, Surface-based Method, Similarity Measures.

Module 5: Shape Descriptor & Shape Matching [6L]:
Geometric Transformation, Shape Contexts, Shape Matching, Thin-Plate Spline Model, Hierarchical Matching of Deformable Shapes, The Shape Tree, Deformation Model, Elastic Matching.

Module 6: Video Processing Basics [6L]:
Digital Video Formation basics, Background subtraction in video, Object Tracking in video, Video Surveillance Applications.

Module 7: Advanced Computer Vision Applications [12L]:
Image Object Detection and Recognition: Face Detection and Recognition, Image Object Segmentation, Image Retrieval, Document Image Processing.

Text Books:

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989 - Technology & Engineering
3. Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

Reference Books:

1. Insight into Images: Principles and Practice for Segmentation, Registration, and Image Analysis, By: T. S. Yoo, 2004
2. Biomedical Images Analysis, by: R. M. Rangayya, 2004, eBook.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	2	2	2
CO2	2	3	2	3	3
CO3	3	2	2	3	2
CO4	3	2	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Quantum Computing**
Course Code: **CSM105D**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Discrete Structures

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the basic idea of quantum computing including background of mathematics and physics required for **Developing** and **Solving** complex engineering problem in the domain of quantum computing possibly using modern engineering tools.
CO2	**Understand** and **Explain** the concept of quantum circuits **Using** single and multiple qubit gates and also **Designing** of quantum circuits for solving engineering problem including societal and environmental issues.
CO3	**Compare** between classical and quantum information theory and **Explain** and **Apply** Bell states, Quantum teleportation, Quantum Cryptography and no cloning theorem in **Solving** engineering problem possibly in a team maintaining proper ethics of professional collaboration.
CO4	**Understand, Explain** and **Apply** different quantum algorithms including classical computation on quantum computers like Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search and also **Relate** between quantum and classical complexity classes for solving engineering problem.
CO5	**Understand** noise and error correction including graph states and codes, quantum error correction, fault-tolerant computation and **Apply** it in **Designing** and **Solving** complex engineering problems leading to their lifelong learning.

Course Content:

Module 1: Introduction to Quantum Computation: [8L]

Quantum bits, Bloch sphere representation of a qubit, multiple qubits. Background Mathematics and Physics: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.

Module 2: Quantum Circuits: [7L]

Single qubit gates, multiple qubit gates, design of quantum circuits.

Module 3: Quantum Information and Cryptography: [7L]

Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.

Module 4: Quantum Algorithms: [7L]

Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.

Module 5: Noise and error correction: [5L]

Graph states and codes, Quantum error correction, fault-tolerant computation.

Text Books:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
3. Pittenger A. O., An Introduction to Quantum Computing Algorithms

Reference Books:

1. P Kaye, R Laflamme and M Mosca, An Introduction to Quantum Computing.
2. Eleanor G. Rieffel , Wolfgang H. Polak , "Quantum Computing - A Gentle Introduction". (Scientific and Engineering Computation)
3. Yanofsky's and Mannucci, Quantum Computing for Computer Scientists.
4. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd.
5. Scott Aaronson, "Quantum Computing since Democritus", Cambridge
6. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	2	2
CO2	3	2	2	3	2
CO3	3	3	2	3	2
CO4	2	3	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Research Methodology and IPR
Course Code: CSM106
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Statistics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** and **Explain** the fundamental concepts of Research Methodology recognizing their utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	**Understand** and **Explain** the research process and perform experimentation with data collection, result observation and interpretation, various result analysis techniques in statistics, Necessary instrumentations.
CO3	**Understand** and **Explain** the fundamental techniques of technical writing and apply the techniques to write scientific articles and prepare for presentation.
CO4	**Understand** and **Explain** the fundamental concepts of Intellectual Property.
CO5	**Understand** and **Explain** the New Developments in IPR for further exploration leading towards lifelong learning.

Course Content:

Module 1: The Research Process: Characteristics and Requirements [8L]:

Types of research, Deciding what to research (formulating a research problem), Planning a research study (conceptualizing a research design, constructing an instrument for data collection, selecting a sample, writing a research proposal), Conducting a research study (collecting data, processing and analyzing data, writing a research report) Meaning of research problem, Sources of research problem, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Module 2: Research Methodology and Approaches [5L]:

investigation of solutions for research problem, Experimentation with data collection, result observation and interpretation, various result analysis techniques in statistics, Necessary instrumentations.
Effective approaches to literature studies and analysis of existing methods. Plagiarism, Research ethics.

Module 3: Effective Technical Writing [12L]:

how to write technical report and research article, Structure of a scientific research article. Latex as scientific editing tool for technical writing. Developing a Research Proposal, Format of research proposal, technical presentation and assessment by a review committee.

Module 4: Nature of Intellectual Property [8L]:

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Module 5: Patent Rights [8L]:

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Module 6: New Developments in IPR [8L]:

Administration of Patent System. IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies, IPR and IITs.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'", Juta & Co Ltd (Publisher)
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016, Aspen Law & Business (Publisher)

Reference Books:

1. Ranjit Kumar, 3rd Edition, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications Ltd.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	2	2
CO2	3	3	2	3	2
CO3	2	2	3	2	2
CO4	2	2	2	2	3
CO5	2	2	2	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Advanced Data Structures and Algorithms Lab
Course Code: CSM192
Contact: 0:0:3
Credits: 3

Prerequisites: Concepts of Data Structure, Programming Knowledge

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of data structure through implementation to **Explain** or **Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of dictionary data structure through implementation and **Analyze** the operations on it.
CO3	**Understand** and **Apply** the fundamental concepts of advanced tree data structures through implementation and **Analyze** the operations on them.
CO4	**Understand** and **Apply** the concepts of set and heap data structures through implementation and **Apply** them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** data structures to the problems of various fields of applications and **Identify** problems where students can **Apply** and **Implement** the concept appropriately through programming with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **Investigate** their effectiveness by **Analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Week 1: Assignments on the application of array data structure to sort a set of elements using different sorting methods (e.g., bubble sort, insertion sort, selection sort etc.)

Week 2: Assignments on the application of array data structure to search an element in a set of elements using different searching methods (e.g., linear search, binary search)

Week 3: Implementation of stack and queue (using array or linked list data structures)

Week 4: Assignments on the application of Dictionaries using the operation viz. creation, deletion, and finding.

Week 5: Implementation of hashing where collision resolution is done using open addressing method

Week 6: Assignments on the implementation of Skip List (e.g. search and update operation)

Week 7: Assignments on the implementation of various trees using array or linked list (e.g. Binary Search Tree, AVL Tree, Red Black Trees, 2-3 Trees, and B-Trees etc.)

Week 8: Implementation of KMP algorithm for pattern matching

Week 9: Implementation of Standard Tries

Week 10: Assignments on the application of array data structure to search an element in a set of elements in Priority Range Trees, Quadtrees, k-D Trees etc.

Week 11: Assignments on Heap Data Structures

Week 12: Mini-Project on Advanced Data Structures: Application of one/ two data structures in real life applications

Text Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2ND Edition, Pearson, 2004.
2. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures, Universities Press
3. Peter Brass; Advanced Data Structures, Cambridge University Press
4. Suman Saha, S. Shukla; Advanced Data Structures: Theory and application, CRC press
5. A.A. Puntambekar; Advanced Data Structures - A Conceptual Approach, Technical Publications

Reference Books:

1. Dinesh P. Mehta, Sartaj Sahni; Handbook of Data Structures and Applications, CRC press
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein; Introduction to Algorithms, fourth edition, The MIT Press

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	3	2	3	2
CO4	3	3	2	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Operating System Lab**
Course Code: **CSM193**
Contact: **0:0:3**
Credits: **3**

Prerequisites: Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence, Python Programming

Course Outcome(s): After completion of the course students will be able to

CO1	**Develop** and test kernel modules, system calls, and process/thread management programs to explore OS internals.
CO2	**Design and implement** CPU scheduling, synchronization, and memory management algorithms, and analyze their performance.
CO3	**Apply** concepts of virtualization and containerization to experiment with system resource allocation and isolation.
CO4	**Implement** distributed OS concepts such as mutual exclusion, event ordering, and distributed file systems through practical programming.
CO5	**Analyze** OS-level security, real-time constraints, and emerging system trends by conducting hands-on experiments with modern Linux/RTOS and distributed environments.

Course Content:

Week 1: **OS Internals & Process Management**

Compile and configure the Linux kernel, Write a simple kernel module (hello module, system call extension), Implement a user-level thread library with context switching, Experiment: Process creation, fork/exec, signal handling.

Week 2: **Scheduling & Synchronization**

Implement custom CPU scheduling algorithms (e.g., Lottery, EDF) in a simulator or modified kernel scheduler, Design and test synchronization primitives (semaphores, monitors, spinlocks), Experiment: Producer-consumer problem using shared memory & semaphores.

Week 3: **Memory Management & Virtualization**

Implement a page replacement algorithm (LRU, Clock, Working Set), Study kernel memory allocation (slab allocator experiment), Lab on QEMU/VirtualBox: installing and running a guest OS, analyzing hypervisor features, Containerization experiment: create and manage lightweight containers using Docker/LXC.

Week 4: **File Systems & Storage**

Implement a simple file system (FUSE-based mini FS), Experiment: journaling vs non-journaling FS performance, Benchmark I/O operations (sequential vs random I/O, caching), Study distributed file system (HDFS/NFS/GlusterFS experiment).

Week 5: Distributed OS Concepts
Implement distributed mutual exclusion algorithms (Ricart–Agrawala / Token Ring), Simulate Lamport's logical clock & vector clocks for event ordering, Mini-project: distributed file sharing service (socket/RPC based), Fault tolerance experiment: checkpointing and recovery in a distributed application.

Week 6: Security, Real-time & Emerging Trends
Implement access control model (capability-based vs ACL simulation), Case study: SELinux/AppArmor policies in Linux, Real-time task scheduling experiment (RTLinux / POSIX real-time API), Cloud/Edge OS experiment: deploy a VM/container cluster, study OS-level resource isolation.

Text Books:

1. Robert Love – Linux Kernel Development (3rd Ed.).
2. Daniel P. Bovet & Marco Cesati – Understanding the Linux Kernel (3rd Ed.)
3. Andrew S. Tanenbaum & Maarten van Steen – Distributed Systems: Principles and Paradigms Covers distributed mutual exclusion, clocks, consensus, file systems (basis for lab experiments)..

Reference Books:

1. Rajib Mall – Real-Time Systems: Theory and Practice
2. Chris Takemura & Luke S. Crawford – The Book of Xen

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	2	1	3	3	2
CO4	3	1	3	3	3
CO5	3	1	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

2nd Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Theory				L T P	Total	
1	Core	CSM201	Advanced Database Management System	3-0-0	3	3
2	Core	CSM202	Data Science and Visualization	3-0-0	3	3
3	Elective III	CSM203A CSM203B CSM203C CSM203D	Internet of Things Advanced Machine Learning Digital Signal Processing High Performance Computing	3-0-0	3	3
4	Elective IV	CSM204A CSM204B CSM204C CSM204D	Blockchain and Cyber Security Natural Language Processing and Large Language Model Pattern Recognition Cloud Computing	3-0-0	3	3
B. Sessional						
5	Audit I	CSM206	**Audit Course-I:** 1. English for Research Paper Writing 2. Disaster Management 3. Sanskrit for Technical Knowledge 4. Value Education	2-0-0	2	0
C. Practical						
6	Core	CSM291	Advanced Database Management System Lab	0-0-3	3	1.5
7	Core	CSM292	Data Science and Visualization Lab	0-0-3	3	1.5
8	Project	CSM281	Mini Project with Seminar	0-0-4	4	2
Total				**14-0-10**	**24**	**17**

****L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]***

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Database Management System**
Course Code: **CSM201**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Discrete Mathematics, Probability and Statistics

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** advanced DBMS architectures, storage, indexing, and optimization.
CO2	**Analyze** relational database design, query execution strategies, concurrency control, and recovery mechanisms.
CO3	**Design** efficient storage, indexing, and distributed data layouts.
CO4	**Apply** core components of a DBMS including buffer manager, join operators, and recovery mechanisms.
CO5	**Evaluate** performance and trade-offs in distributed, parallel, and cloud-native systems.

Course Content:

Module 1: Relational Database Design [6L]:

Formal review of relational database and FDs Implication, Closure, its correctness, 1NF, 2NF, 3NF and BCNF, Decomposition and synthesis approaches

Module 2: Data Warehousing and Data Mining [7L]:

Concepts, architecture, OLTP vs OLAP, data cube & operations (roll-up, drill-down, slice, dice, pivot), ETL process, data preprocessing, Introduction to KDD, tasks (predictive & descriptive), association rule mining (Apriori, FP-growth, interestingness measures), classification (decision trees, Bayesian, k-NN, SVM), clustering (k-means, hierarchical, DBSCAN),

Module 3: Storage and Indexing [6L]:

File organization: heap files, clustered/unclustered storage, slotted page structures, Buffer management: replacement policies (LRU, CLOCK, MRU, 2Q), Index structures, B-Tree & B+ Tree internals: insertion, deletion, search performance, Static vs. dynamic hashing: extendible, linear hashing, Bitmap indexing for OLAP workloads, R-Trees and GiST for spatial/multimedia data, Access paths, covering indexes, index-only scans.

Module 4: Query Processing and Optimization [3L]:

Relational operators and iterator (Volcano) model, Join algorithms: nested loop, block nested loop, sort-merge join, hash join, Sorting and aggregation strategies, Query optimization: Rule-based vs. cost-based, Cost estimation (I/O, CPU models), Selectivity estimation, histograms, sampling, sketches, Join ordering: dynamic programming (Selinger-style), bushy vs. left-deep trees, Predicate pushdown, projection pushdown, materialization vs. pipelining.

Module 5: Transactions, Concurrency & Recovery [6L]:

Transaction concepts: ACID properties, schedules, serializability, recoverability, Concurrency control: 2PL (strict, conservative), timestamp ordering, Multi-Version Concurrency Control (MVCC), Optimistic concurrency control, Deadlock handling: wait-die, wound-wait, detection & timeout, Recovery: Write-Ahead Logging (WAL), Checkpointing, shadow paging, ARIES algorithm: redo, undo, log record types.

Module 6: Distributed and Parallel Databases [6L]:

Distributed DBMS architecture: transparency levels, Data fragmentation (horizontal, vertical, hybrid), Distributed transactions: 2PC, 3PC, coordinator failures, Replication strategies: eager vs. lazy; primary vs. multi-master, Consistency models: strong, eventual, causal, CAP theorem and PACELC, Parallel databases: Shared-nothing vs. shared-disk, Parallel join strategies, partitioned hash joins, skew handling.

Module 7: Advanced Data Models[5L]:

Graph databases: property graph model, Cypher/Gremlin queries, reachability & pattern matching, Spatial & temporal databases: R-Trees, Quad-trees, indexing temporal intervals.

Text Books:

1. Ramakrishnan, R. & Gehrke, J. – Database Management Systems, 3rd Edition, McGraw-Hill.
2. Silberschatz, A., Korth, H.F., & Sudarshan, S. – Database System Concepts, 7th Edition, McGraw-Hill.
3. Elmasri, R. & Navathe, S.B. – Fundamentals of Database Systems, 7th Edition, Pearson.

Reference Books:

1. Garcia-Molina, H., Ullman, J.D., & Widom, J. – Database Systems: The Complete Book, 2nd Edition, Pearson.

2. Jim Gray & Andreas Reuter – Transaction Processing: Concepts and Techniques, Morgan Kaufmann.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Data Science and Visualization**
Course Code: **CSM202**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Discrete Mathematics, Probability and Statistics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the fundamental concepts, workflow, and applications of data science and distinguish between structured and unstructured data.
CO2	**Apply** data preprocessing and wrangling techniques, including handling missing data, feature engineering, and integrating multiple datasets.
CO3	**Develop** and interpret effective visualizations using Python libraries to represent patterns, trends, and relationships in datasets.
CO4	**Perform** exploratory data analysis (EDA), statistical analysis, and hypothesis testing to extract actionable insights from data.
CO5	**Design** and present end-to-end data science workflows, including advanced visualization, dashboards, and ethical considerations in data representation.

Course Content:

Module 1: Foundations of Data Science: [6L]:

Introduction to Data Science: concepts, applications, workflow; Types of data: structured vs unstructured, formats (CSV, JSON, databases); Basics of Python/R for data science; Data collection: files, APIs, web scraping basics; Data exploration: descriptive statistics (mean, median, std. dev, distributions);
Tools overview: Jupyter Notebook, Google Colab, Anaconda.

Module 2: Data Preprocessing and Wrangling [7L]:

Handling missing data, duplicates, outliers; Data cleaning and transformations; Feature engineering and encoding categorical variables; Data integration and merging datasets; Data manipulation with Pandas; Working with time-series and text data basics.
Case study: Cleaning a Messy Dataset.

Module 3: Data Visualization Basics [8L]:

Principles of good visualization: storytelling with data; Matplotlib: line, bar, histogram, pie charts; Customizing plots (labels, colors, legends, annotations); Subplots and multiple graphs; Seaborn basics: statistical plots (box, violin, scatter, pairplot); Advanced Seaborn visualizations: heatmaps, categorical plots; Visualizing time-series and trends.
Mini-project: real-world dataset visualization.

Module 4: Applied Data Science & Visualization [8L]:

Exploratory Data Analysis (EDA): step by step; Correlation and relationships between variables; Interactive visualization with Plotly/dashboards; Case study: business decision-making with visualization; Basics of probability & distributions; Hypothesis testing and confidence intervals; Data storytelling: visuals + narrative.
Mini-project: survey/business dataset analysis.

Module 5: Advanced Visualization & Applications [7L]:
Visualizing big data (sampling, aggregation, dashboards); Geographic visualizations (maps, geopandas, plotly maps); Network graphs and hierarchical data visualization; Machine learning visualizations (scatter, decision boundaries); Automating reports (Jupyter, dashboards, exporting plots); Ethics of data visualization (misleading graphs, bias).
Final project presentation: complete workflow.

Text Books:

1. Data Visualization: Storytelling Using Data. Sharada Sringeswara; Purvi Tiwari; U. Dinesh Kumar. ISBN: 9354643132. Wiley.
2. Hand Book on Data Visualization: Easy to quick practices. Dr. Appala Srinuvasu Muttipati. ISBN: 979-8891862920. Notion Press.
3. Introduction to Data Science:Practical Approach with R and Python. B. Uma Maheswari and R. Sujatha. ISBN: 9354640508. Wiley.
4. Data Science From Scratch: First Principles with Python. Joel Grus. ISBN: 9352138325. Shroff/O'Reilly.

Reference Books:

1. Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures. Claus O. Wilke. ISBN: 9352138112. Shroff/O'Reilly.
2. Data Science: A Beginner's Guide. C. Raju. ISBN: 0143461729. Penguin Business.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	3	3	2	2	3
CO4	3	3	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Internet of Things**
Course Code: **CSM203A**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Computer Networks, Embedded Systems, Wireless Communications, Basic Programming

Course Outcome(s): After completion of the course students will be able to

CO1	**Analyze** real-world IoT design constraints and **Build** layered IoT architectures and distinguish IoT from M2M systems.
CO2	**Compare and apply** various IoT protocols across networking and application layers.
CO3	**Implement** IoT systems using embedded hardware, sensors, and communication modules.
CO4	**Apply** IoT middleware, data analytics, and cloud/fog integration.
CO5	**Evaluate** IoT deployments with regard to security, scalability, and industry use cases.

Course Content:

Module 1: IoT Overview & Architecture [5L]:

IoT definitions, applications, challenges, and benefits, IoT layers & components (sensors, actuators, connectivity, data processing), IoT vs. M2M, reference architectures (oneM2M, IoTWF, CoAP/MQTT stacks), IoT architectural principles, functional/information view, deployment models, Business processes: Everything-as-a-Service (XaaS), IoT analytics.

Module 2: Embedded Hardware & Sensing [5L]:

Overview of sensor types (temperature, humidity, motion, etc.), edge computing, and data processing, Microcontroller platforms (Arduino, Raspberry Pi), MTconnectors (Bluetooth, WiFi, GSM/GPRS), sensor interfacing, Hands-on interfacing basics and hardware architectures.

Module 3: Communication Interfaces & Protocols [6L]:

IoT access technologies: RFID, ZigBee/802.15.4, Bluetooth/BLE, LoRa, NB-IoT, Wi-Fi, IPv6 for IoT, 6LoWPAN, RPL, CoAP, MQTT, REST, Web of Things, service discovery, middleware stacks.

Module 4: IoT Middleware & Data Analytics [5L]:

IoT middleware and platforms, data ingestion and processing pipelines, Big Data analytics tools tailored for IoT data streams and real-time insights, Applications in smart environments (cities, grids, healthcare, manufacturing).

Module 5: Cloud, Fog & Edge Integration [5L]:
Cloud computing for IoT support, sensor clouds, and edge/fog computing paradigms, Data distribution between edge, fog, and cloud; XaaS models, Architectural decisions for latency-sensitive IoT applications.

Module 6: Security, Privacy & Reliability [5L]:
IoT vulnerabilities: hardware/software, network-level threats, device authentication, Lightweight security protocols, blockchain for IoT, trust and privacy management, Security in SCADA, ZigBee/BLE, side-channel attacks.

Module 7: IoT Applications & Case Studies [5L]:
Deep dives into real-world use cases: Smart cities, smart manufacturing, smart healthcare, smart transportation, Design considerations: scalability, context awareness, data analytics, UX.

Text Books:

1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing.
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermsan.
3. Giancarlo Fortino & Paolo Trunfio — IoT Based on Smart Objects — Technology, Middleware and Applications.

Reference Books:

1. Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing.
2. O. Hersent, D. Boswarthick & O. Elloumi — The Internet of Things: Key Applications and Protocols

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	2	3	2	3	2
CO3	3	2	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Machine Learning**
Course Code: **CSM203B**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Prior course in Machine Learning & Probability/Statistics, Linear Algebra, Programming (Python/Matlab)

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** advanced theoretical underpinnings of learning theory (PAC, VC dimension, generalization)
CO2	**Analyze and apply** kernel-based methods, probabilistic graphical models, and Bayesian inference.
CO3	**Design** and train advanced deep learning architectures for structured and sequential data.
CO4	**Apply** reinforcement learning paradigms for decision-making under uncertainty
CO5	Critically **evaluate, implement,** and optimize advanced ML systems for real-world applications.

Course Content:

Module 1: Basics of Machine Learning [3L]:

Overview of supervised, unsupervised, and reinforcement learning, Linear Regression, Logistic Regression, Decision Trees, Random Forests, k-NN, Naïve Bayes classifiers, Overfitting, underfitting, cross-validation, Evaluation metrics: accuracy, precision, recall, F1, ROC.

Module 2: Foundations of Advanced Learning Theory [6L]:

Review of classical ML: bias-variance tradeoff, empirical risk minimization, Probably Approximately Correct (PAC) Learning – learnability, hypothesis space, sample complexity, VC Dimension & Rademacher Complexity – measures of capacity, bounds on generalization, Structural Risk Minimization (SRM), Boosting (AdaBoost, Gradient Boosting) and Online Learning frameworks.

Module 3: Kernel Methods & Nonlinear Learning [4L]:

Review of Support Vector Machines (classification and regression), Kernel Trick: common kernels (polynomial, RBF, string kernels), Kernel PCA and dimensionality reduction, Multiple Kernel Learning (MKL), Applications of kernel methods in NLP and vision.

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Module 4: Probabilistic Graphical Models [5L]:

Directed Models: Bayesian Networks, d-separation, conditional independence, Undirected Models: Markov Random Fields, factor graphs, Inference in PGMs: Variable elimination, Belief Propagation, Junction Tree algorithm, Learning in PGMs: Parameter estimation (MLE, MAP), Structure learning, Approximate inference: Sampling methods (MCMC, Gibbs Sampling), Variational Inference.

Module 5: Deep Learning & Advanced Architectures [7L]:

Review: MLP, Backpropagation, optimization (SGD, Adam), CNN Architectures: AlexNet, VGG, ResNet, EfficientNet, RNN and Variants: LSTM, GRU, Attention Mechanisms, Transformers: Self-attention, BERT, GPT-style models, Autoencoders & Representation Learning, Regularization techniques: dropout, batch normalization, data augmentation.

Module 6: Reinforcement Learning [3L]:

Markov Decision Processes (MDPs), Value Iteration, Policy Iteration, Q-Learning, Temporal Difference (TD) learning and Eligibility Traces, Policy Gradient Methods: REINFORCE, Actor-Critic methods, Deep RL: Deep Q-Networks (DQN), PPO, A3C, Applications: Robotics, games (Atari, Go), recommendation systems.

Module 7: Advanced Topics in Machine Learning [5L]:

High-dimensional data and curse of dimensionality, Manifold Learning: t-SNE, UMAP, Isomap, Bayesian Nonparametrics: Gaussian Processes, Dirichlet Processes, Generative Models: Variational Autoencoders (VAE), Generative Adversarial Networks (GANs), Explainability in ML: SHAP, LIME, Interpretable models, Fairness, Ethics & Trustworthy AI.

Module 8: Applications & Case Studies [3L]:

Natural Language Processing: sequence-to-sequence models, large language models, Computer Vision: image segmentation, object detection, video analytics, Bioinformatics: gene expression, protein structure prediction, Healthcare: disease diagnosis, medical imaging, precision medicine, Smart Cities: traffic prediction, energy optimization.

Text Books:

1. Shai Shalev-Shwartz & Shai Ben-David — Understanding Machine Learning: From Theory to Algorithms.
2. Ian Goodfellow, Yoshua Bengio & Aaron Courville — Deep Learning.
3. Christopher Bishop — Pattern Recognition and Machine Learning.

Reference Books:

1. Kevin Murphy — Probabilistic Machine Learning: An Introduction.
2. Sutton & Barto — Reinforcement Learning: An Introduction.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman — The Elements of Statistical Learning.

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Digital Signal Processing
Course Code: CSM203C
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Knowledge of Signals and Systems, Linear Algebra, Probability and Statistics, and Programming in MATLAB/Python.

Course Outcome(s): After completion of the course, students will be able to

CO1	**Explain** the concepts of discrete-time signals and systems, their properties, and mathematical representations.
CO2	**Apply** Z-transform, DFT, and FFT techniques for signal analysis in the time and frequency domains.
CO3	**Analyze** and compare FIR and IIR digital filters, including their design methods and realizations.
CO4	**Design and Implement** efficient DSP algorithms using FFT, polyphase structures, and multirate processing concepts.
CO5	**Evaluate** the applications of DSP techniques in speech, audio, biomedical, image, and communication systems.

Course Content:

Module 1: Discrete-Time Signals and Systems [6L]:

Classification of signals, properties of discrete-time systems, linear time-invariant (LTI) systems, convolution, difference equations, stability, and causality.

Module 2: Transform Techniques [8L]:

Z-transform and its properties, Discrete Fourier Transform (DFT), properties of DFT, Fast Fourier Transform (FFT) algorithms, applications of transforms in spectral analysis.

Module 3: Digital Filter Design [8L]:

FIR filter design: windowing, frequency sampling, Parks-McClellan algorithm. IIR filter design: impulse invariance, bilinear transformation. Comparison of FIR and IIR filters, filter realizations and structures.

Module 4: Efficient DSP Algorithms [6L]:

FFT algorithms (radix-2, radix-4), computation of convolution using FFT, polyphase structures, multirate signal processing basics, decimation, interpolation, filter banks.

Module 5: Applications of DSP [8L]:

Case studies in audio and speech processing, biomedical signal analysis, communication systems, and image/video processing. Introduction to advanced topics: DSP processors and real-time implementations.

Text Books:

1. John G. Proakis and Dimitris G. Manolakis – *Digital Signal Processing: Principles, Algorithms, and Applications*, Pearson.
2. Alan V. Oppenheim and Ronald W. Schafer – *Discrete-Time Signal Processing*, Pearson.

Reference Books:

1. Sanjit K. Mitra – *Digital Signal Processing: A Computer-Based Approach*, McGraw Hill.
2. Monson H. Hayes – *Digital Signal Processing*, Schaum's Outline, McGraw Hill.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	2	1
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **High Performance Computing**
Course Code: **CSM203D**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Computer Architecture, Operating Systems, Basics of Algorithms

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** parallel hardware and memory hierarchies; reason about performance limits using Amdahl/Gustafson and roofline-style thinking.
CO2	**Understand** Program shared-memory and distributed-memory systems using OpenMP and MPI, and apply GPU programming (CUDA/OpenCL) for accelerators.
CO3	**Design and analyze** parallel algorithms (dense/sparse linear algebra, graph algorithms, FFT, Monte Carlo) for multi/many-core systems.
CO4	**Analyze** Profile, tune, and scale applications; reason about load balance, communication/computation overlap, and NUMA/affinity.
CO5	**Apply** HPC ecosystems (libraries, batch schedulers, containers) and follow reproducible and energy-aware practices on clusters/supercomputers.

Course Content:

Module 1: Foundations of HPC [4L]:

Introduction to HPC, Application domains; capability vs. capacity computing, Flynn's taxonomy (SISD/SIMD/MISD/MIMD); throughput vs. latency, Modern node anatomy: multi-core CPUs, SIMD/vectorization, caches, NUMA, Performance models: Amdahl's and Gustafson's laws; strong/weak scaling.

Module 2: Parallel Architectures & Interconnects [4L]:

Shared-memory vs. distributed-memory vs. hybrid nodes, Memory hierarchy, cache coherence basics, NUMA placement & affinity, Interconnects & collectives: topology, bisection bandwidth, latency; brief on InfiniBand concepts, Overview of cluster and supercomputer organization; exascale trends (conceptual).

Module 3: Shared-Memory Programming with OpenMP [5L]:

Threads, worksharing, tasks; scheduling & granularity, Synchronization: critical/atomic, locks, barriers; false sharing & locality, Reductions; nested parallelism; task dependences, Performance pitfalls & tuning on NUMA nodes

Module 4: Distributed-Memory Programming with MPI [6L]:

Point-to-point vs. non-blocking communication; collectives; communicators, Cartesian topologies; domain decomposition; ghost cells & halo exchange, Overlap computation/com munication; latency hiding; process mapping, Hybrid MPI+OpenMP design patterns.

Module 5: GPU/Accelerator Programming [5L]:

GPU architecture: SMs, warps, occupancy, memory hierarchy, CUDA kernels, grids/blocks/ threads; memory coalescing; shared memory tiling, OpenCL basics; brief on OpenACC/SYCL ecosystem awareness, Roofline-style reasoning for GPUs; kernel profiling & optimization patterns.

Module 6: Parallel Algorithms & Libraries [6L]:

Dense linear algebra (BLAS/LAPACK/ScaLAPACK); blocking/tiling; GEMM; LU/Chole sky, Sparse matrix operations; SpMV; graph-based workloads (BFS/PageRank), FFT and spectral methods; Monte Carlo; stencil computations, Using PETSc and ecosystem libraries for scalability.

Module 7: Performance Engineering & Tools [4L]:

Metrics: runtime, speedup, efficiency, scalability, arithmetic intensity, Instrumentation & profiling workflows; using representative toolchains (e.g., compiler reports, gprof/perf, MPI profilers; GPU profilers conceptually), Load balance, locality, vectorization reports; case-study driven tuning.

Text Books:

1. Grama, Gupta, Karypis, Kumar – Introduction to Parallel Computing: Design and Analysis of Algorithms, 2e.
2. Kirk & Hwu – Programming Massively Parallel Processors: A Hands-on Approach, 4e.
3. Michael J. Quinn – Parallel Programming in C with MPI and OpenMP.

Reference Books:

1. Thomas Sterling, Matthew Anderson – High Performance Computing: Modern Systems and Practices.
2. Rajkumar Buyya et al. – High Performance Cluster Computing.
3. Jack Dongarra et al. – Numerical Linear Algebra for High Performance Computers.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	3	2	3	2
CO5	2	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Blockchain & Cyber Security**
Course Code: **CSM204A**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Fundamentals of Computer Networks, Cryptography, Algorithms, and Information Security.

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** cryptographic primitives and their role in secure distributed systems.
CO2	**Describe** blockchain architectures, consensus mechanisms, and smart-contract platforms.
CO3	**Analyze** security, privacy and scalability threats in blockchain systems and propose mitigations.
CO4	**Apply** modern cyber-security practices to secure blockchain-based applications and networks.
CO5	**Implement** smart contracts and build secure dApps; perform basic forensic and audit analysis.

Course Content:

Module 1: Cryptographic Foundations [6L]:

Basics of cryptography: symmetric vs. asymmetric cryptography, Cryptographic hash functions and Merkle trees, Digital signatures: RSA, ECDSA, Schnorr, Key management, PKI, certificates, Zero-knowledge proofs (introductory), commitment schemes, Cryptographic primitives used in blockchains

Module 2: Blockchain Architecture & Consensus [7L]:

Evolution of blockchain: Bitcoin, Ethereum, permissioned vs. permissionless systems, Data structures: blocks, transactions, UTXO vs. account-based models, Consensus protocols: Proof-of-Work, Proof-of-Stake, PBFT, Raft, hybrid approaches, Peer-to-peer networking and transaction propagation, Scalability issues: sharding, pruning, layer-2 solutions

Module 3: Smart Contracts & Platforms [6L]:

Smart contracts: definition, architecture, execution environment (EVM), Solidity fundamentals and smart contract design patterns (conceptual overview), Decentralized applications (dApps): architecture, front-end integration, use cases, Gas economics and contract lifecycle management, Challenges: upgradability, verification, and correctness.

Module 4: Blockchain Security [5L]:

Security analysis of blockchain protocols Network-level attacks: eclipse, routing, Sybil attacks Consensus-level attacks: 51% attack, selfish mining, double-spending, Smart contract vulnerabilities: reentrancy, overflows/underflows, denial-of-service, access control issues, Privacy issues: deanonymization, transaction graph analysis, Mitigation strategies and best practices

Module 5: Privacy, Scalability & Advanced Cryptography [6L]:
Advanced privacy-preserving techniques: ring signatures, zk-SNARKs, zk-STARKs, mixers, Confidential transactions and threshold cryptography, Scalability approaches: rollups, state channels, sidechains, Plasma, Trade-offs between decentralization, scalability, and security

Module 6: Auditing, Forensics & Governance [6L]:
Security auditing of smart contracts and blockchain platforms, Blockchain forensics: tracing transactions, detection of illicit activities, Legal and regulatory perspectives: compliance, data protection, KYC/AML, Governance models: on-chain vs. off-chain, DAOs, attack scenarios, Ethical, economic, and societal implications of blockchain and cyber security.

Text Books:

1. Andreas M. Antonopoulos – Mastering Bitcoin: Unlocking Digital Cryptocurrencies (O'Reilly)
2. Andreas M. Antonopoulos & Gavin Wood – Mastering Ethereum: Building Smart Contracts and DApps (O'Reilly)
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder – Bitcoin and Cryptocurrency Technologies (Princeton University Press)

Reference Books:

1. Nir Kshetri – Blockchain and Cybersecurity: Blockchain's Roles in Security, Privacy and Transparency (MIT Press / Springer)
2. Behrouz A. Forouzan – Cryptography and Network Security (McGraw-Hill)

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	2	3
CO2	2	3	2	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	2
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Natural Language Processing and Large Language Model**
Course Code: **CSM204B**
Contact: **3:0:0**
Total Contact Hours: **36**
Credits: **3**

Prerequisites: Discrete Mathematics, Probability and Statistics

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the basic concepts of NLP to **Explain** or **Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Text Preprocessing and Morphology so that they can **Apply** the concept to **Analyze** their **CORPUS**.
CO3	**Explain** or **Illustrate** the fundamental strategies of Language Modelling and **Word Sense** Disambiguation acquiring enough knowledge to **Propose** models for Word Prediction & **Disambiguation** and **Evaluate** their performances.
CO4	**Explain** or **Illustrate** the concepts of Markov Model for POS Tagging and Probabilistic Context Free Grammars and Probabilistic parsing so that they can **Apply** them to **Solve** the relevant problems and **Analyze** their performances
CO5	**Develop** ideas to **Propose** solutions to the problems of Syntax & Semantics Analysis for Machine Translation and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions underscoring the utilitarian importance for further exploration of NLP issues leading towards lifelong learning.

Course Content:

Module 1: Introduction to NLP [3L]:

Introduction to NLP - Various stages of NLP –The Ambiguity of Language: Why NLP Is Difficult Parts of Speech: Nouns and Pronouns, Words: Determiners and adjectives, verbs, Phrase Structure. Statistics Essential Information Theory: Entropy, perplexity, The relation to language, Cross entropy.

Module 2: Text Preprocessing and Morphology [4L]:

Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis. Inflectional and Derivation Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer.

Module 3: Language Modeling [5L]:

Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models.

Module 4: Word Sense Disambiguation [5L]:

Methodological Preliminaries, Supervised Disambiguation: Bayesian classification, An information theoretic approach, Dictionary-Based Disambiguation: Disambiguation based on sense, Thesaurus based disambiguation, Disambiguation based on translations in a second-language corpus.

Module 5: Markov Model and POS Tagging [5L]:

Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging.

Module 6: Probabilistic Context Free Grammars and Probabilistic parsing [5L]:

The Probability of a String, Problems with the Inside-Outside Algorithm, Parsing for disambiguation, Treebanks, Parsing models vs. language models, Phrase structure grammars and dependency, Lexicalized models using derivational histories, Dependency-based models.

Module 7: Syntax & Semantics Analysis and Machine Translation [4L]:

Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, WordNet, Thematic Roles, Semantic Role Labelling with CRFs. Statistical Alignment and Machine Translation, Text alignment, Word alignment, Information extraction, Text mining, Information Retrieval, NL interfaces, Sentimental Analysis, Question Answering Systems, Social network analysis.

Module 8: Large Language Models [5L]:

Self-attention mechanism, positional encoding, encoder-decoder vs decoder-only models; examples (BERT, GPT, T5, LLaMA), Text generation, summarization, translation, question answering, reasoning, code generation, multimodal extensions.

Text Books:

1. Speech and Language Processing, Jurafsky and Martin, Pearson Education
2. Foundation of Statistical Natural Language Processing, Manning and Schutze, MIT Press
3. Multilingual Natural Language Processing Applications from Theory to Practice: Bikel, Pearson.
4. Ela Kumar, “Natural Language Processing’, Wiley

Reference Books:

1. Allen, James. 1995. – “Natural Language Understanding”. Benjamin/Cummings, 2ed.
2. Bharathi, A., Vineet Chaitanya and Rajeev Sangal. 1995. Natural Language Processing- “A Paninian Perspective”. Prentice Hll India, Eastern Economy Edition.

3. Hobson lane, Cole Howard, Hannes Hapke, "Natural language processing in action" MANNING Publications, 2019

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	3	2	3	2
CO3	3	3	2	2	3
CO4	3	2	3	3	3
CO5	3	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Pattern Recognition
Course Code: CSM204C
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Knowledge of Probability and Statistics, Linear Algebra, Machine Learning basics, and Programming in Python/Matlab.

Course Outcome(s): After completion of the course, students will be able to

CO1	**Explain** the fundamental concepts of pattern recognition, decision theory, and data representation.
CO2	**Apply** statistical and machine learning techniques for supervised and unsupervised classification.
CO3	**Analyze** feature extraction, dimensionality reduction, and clustering algorithms for pattern recognition tasks.
CO4	**Design and Implement** recognition systems using discriminant functions, neural networks, and support vector machines.
CO5	**Evaluate** the performance of pattern recognition systems in real-world applications such as biometrics, speech, image, and text recognition.

Course Content:

Module 1: Introduction to Pattern Recognition [6L]:

Basics of pattern recognition, applications, stages of PR system, Bayesian decision theory, maximum likelihood estimation, and discriminant functions.

Module 2: Supervised Classification [8L]:

Parametric and non-parametric classifiers, k-Nearest Neighbors, decision trees, linear classifiers, Fisher's Linear Discriminant, SVM basics.

Module 3: Unsupervised Learning & Clustering [6L]:

K-means, hierarchical clustering, Gaussian Mixture Models, Expectation-Maximization algorithm, cluster validity indices.

Module 4: Feature Extraction and Dimensionality Reduction [8L]:

Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), feature selection, feature normalization, kernel methods.

Module 5: Applications of Pattern Recognition [8L]:

Case studies in biometrics (face, fingerprint, iris recognition), speech and speaker recognition, text and handwriting recognition, image-based recognition, introduction to deep learning for pattern recognition.

Text Books:

1. Christopher M. Bishop – *Pattern Recognition and Machine Learning*, Springer.
2. Sergios Theodoridis and Konstantinos Koutroumbas – *Pattern Recognition*, Academic Press.

Reference Books:

1. Richard O. Duda, Peter E. Hart, and David G. Stork – *Pattern Classification*, Wiley.
2. Andrew R. Webb and Keith D. Copsey – *Statistical Pattern Recognition*, Wiley.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	2	1
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Cloud Computing
Course Code: CSM204D
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Basic knowledge in Computer Network and Distributed System

Course Outcome(s): After completion of the course students will be able to

CO1	**Identify** the appropriate cloud services for a given application
CO2	**Assess** the comparative advantages and disadvantages of Virtualization technology
CO3	**Analyze** authentication, confidentiality and privacy issues in cloud computing
CO4	**Identify** security implications in cloud computing.
CO5	**Understand** and **Explain** the importance of protocols and standards in management for cloud services.

Course Content:

Module 1: Definition of Cloud Computing and its Basics [10L]

Definition of Cloud Computing: Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models (Public, Private, Hybrid and Community Clouds), Service models – Infrastructure as a Service, Platform as a Service, Software as a Service with examples of services/ service providers, Cloud Reference model, Characteristics of Cloud Computing – a shift in paradigm Benefits and advantages of Cloud Computing.

Cloud Architecture: Cloud Infrastructure, Architecture of each component, Virtualization versus Traditional Approach, Virtualization Model for Cloud Computing.

Services and Applications by Type
IaaS – Basic concept, Workload, partitioning of virtual private server instances, Pods, aggregations, silos.
PaaS – Basic concept, tools and development environment with examples
SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform Identity as a Service (IDaaS) Compliance as a Service (CaaS)

Module 2: Use of Platforms in Cloud Computing [10L]

Concepts of Abstraction and Virtualization

Virtualization technologies: Types of virtualizations, Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing; Classification of Virtualization Environment: Scheduling-based Environment, Load-Distribution-Based Environment, Energy Aware-Based Environment, OperationalBased Environment, Distributed Pattern-Based Environment, Transactional-Based Environment.

Mention of The Google Cloud as an example of use of load balancing Hypervisors: Virtual machine technology and types, VMware vSphere Machine imaging (including mention of Open Virtualization Format – OVF)
Porting of applications in the Cloud: The simple Cloud API and AppZero Virtual Application appliance Concepts of Platform as a Service
Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development. Use of PaaS Application frameworks.

Module 3: Cloud Service Models [10L]

Use of Google Web Services: Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service.
Use of Amazon Web Services: Amazon Web Service components and services: Amazon Elastic Cloud, Amazon Simple Storage system, Amazon Elastic Block Store, Amazon SimpleDB and Relational Database Service
Use of Microsoft Cloud Services: Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services

Module 4: Cloud Infrastructure [10L]

Types of services required in implementation – Consulting, Configuration, Customization and Support
Cloud Management: An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, Monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle)
Live Migration of Virtual Machines: Need of Live Migration of Virtual Machine, A Designing Process of Live Migration, and Security Issues during live migration.
Concepts of Cloud Security: Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security, Identity and Access Management.
Auditing and Compliance in Cloud Environment: Data Security in Cloud Computing Environment, Need for Auditing in Cloud Computing Environment, Third Party Service Provider, Cloud Auditing Outsourcing Lifecycle Phases, Auditing Classification.

Module 5: Concepts of Services and Applications [8L]

Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs

Applications in the Cloud: Concepts of cloud transactions, functionality mapping, Application attributes, Cloud service attributes, System abstraction and Cloud Bursting, pplications and Cloud APIs

Cloud-based Storage: Cloud storage definition – Manned and Unmanned.

Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services

Text Books:

1. Kai Hwang, Geoffrey C Fox, Jack J Dongarra: Distributed and Cloud Computing – From Parallel Processing to the Internet of Things, Morgan Kaufmann Publishers – 2012.

2. Barrie Sosinsky, "Cloud Computing Bible", Wiley India Edition.

Reference Books:

1. Anthony Velte, tobyVelte, Robert Elsenpeter, "Cloud Computing – A Practical Approach", Tata McGraw-Hill Edition.

2. Alex Amies, Harm Sluiman, Qiang Guo Tong and Guo Ning Liu: Developing and Hosting Applications on the cloud, IBM Press, 2012.

3. George Reese: Cloud Application Architectures: Building Applications and Infrastructure in the Cloud (Theory in Practice), O'Reilly Publications, 2009

4. Haley Beard: Cloud Computing Best Practices for Managing and Measuring Processes for Ondemand Computing – applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, July 2008

5. Michael Miller: Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Pearson Education, 2009.

6. Richard N. Katz: The Tower and The Cloud, Higher Education in the Age of Cloud Computing, 2008.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	3	2
CO2	2	3	2	2	2
CO3	3	2	3	3	3
CO4	3	2	3	2	3
CO5	2	3	2	3	2

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Audit Course-I
Course Code: CSM206
Contact: 2:0:0
Total Contact Hours: 24
Credits: 2

Subjects to Choose

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

English for Research Paper Writing

Course Outcome(s): After completion of the course students will be able to

CO1	**Demonstrate** an understanding of the purpose, types, and structure of research papers while applying appropriate academic style, tone, and language.
CO2	**Develop** skills to write clear and concise abstracts, titles, literature reviews, methodology, and results sections with coherence and logical flow.
CO3	**Apply** effective paraphrasing, summarizing, and citation practices using standard referencing styles (APA, MLA, IEEE) to maintain academic integrity.
CO4	**Critically analyze** and produce well-structured discussion and conclusion sections, ensuring clarity of argument and scholarly contribution.
CO5	**Enhance** research manuscripts through editing, proofreading, plagiarism avoidance, and formatting for submission to journals and conferences.

Course Content:

Module 1: Introduction to Research Writing [8L]:

Purpose and types of research papers. Structure of a research paper (Abstract, Introduction, Methods, Results, Discussion, Conclusion). Academic style, tone, and language in research writing. Common mistakes in research writing.

Module 2: Writing Components of a Research Paper [8L]:

Writing effective abstracts and titles. Literature review: summarizing, paraphrasing, and citing sources. Writing methodology and results sections. Argumentation, coherence, and logical flow.

Module 3: Language Modeling [8L]:

Discussion and conclusion writing. Citation styles (APA, MLA, IEEE) and reference management. Editing, proofreading, and avoiding plagiarism. Preparing manuscripts for journals and conferences.

Text Books:

1. Day, R. A., & Gastel, B. – How to Write and Publish a Scientific Paper, Cambridge University Press.
2. Wallwork, A. – English for Writing Research Papers, Springer.

Reference Books:

1. Glasman-Deal, H. – Science Research Writing for Non-Native Speakers of English, Imperial College Press.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	2	2	2
CO2	2	3	3	2	2
CO3	2	3	2	3	2
CO4	3	3	3	2	3
CO5	3	3	2	2	2

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Disaster Management

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** the concepts, types, causes, and impacts of natural and man-made disasters, along with key terms such as hazard, vulnerability, risk, and resilience.
CO2	**Analyze** hazard assessment, vulnerability analysis, and early warning systems to design effective disaster preparedness and risk reduction strategies.
CO3	**Evaluate** the role of community participation, awareness programs, and resource mobilization in strengthening resilience against disasters.
CO4	**Demonstrate** an understanding of emergency response planning, coordination mechanisms, and mitigation measures adopted by governmental and non-governmental organizations.
CO5	**Critically assess** post-disaster recovery, rehabilitation, and reconstruction processes through real-world case studies to derive lessons for future disaster management.

Course Content:

Module 1: Introduction to Disaster Management [8L]:

Definition and concept of disasters. Types of disasters: natural (earthquake, flood, cyclone, landslide) and man-made (industrial accidents, terrorism). Causes and impacts of disasters. Key concepts: hazard, vulnerability, risk, resilience. Importance of disaster management frameworks at local, national, and global levels.

Module 2: Disaster Preparedness and Risk Reduction [8L]:

Hazard assessment and vulnerability analysis. Early warning systems and monitoring. Community-based disaster preparedness programs. Public awareness and training for disaster mitigation. Resource mobilization and strengthening resilience at community and organizational levels.

Module 3: Disaster Response, Mitigation, and Recovery [8L]:

Emergency response planning and coordination among agencies. Role of governmental and non-governmental organizations. Structural and non-structural mitigation measures. Post-disaster recovery, rehabilitation, and reconstruction. Case studies of past disasters to analyze challenges and lessons learned.

Text Books:

1. Gupta, Anil K. & Nandita Sengupta – Disaster Management: Concepts and Approaches, PHI Learning.
2. Carter, W. Nick – Disaster Management: A Disaster Manager's Handbook, Asian Development Bank.
3. Coppola, Damon P. – Introduction to International Disaster Management, Butterworth-Heinemann (Elsevier).

Reference Books:

1. Alexander, David – Principles of Emergency Planning and Management, Oxford University Press.
2. Goel, S. L. – Disaster Management, Deep & Deep Publications.
3. Kapur, Anu, & Yogesh Dhameja – Disaster Management in India: Approaches and Strategies, PHI.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	1	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	3	2	3	1
CO5	3	2	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Sanskrit for Technical Knowledge

Course Outcome(s): After completion of the course students will be able to

CO1	**Demonstrate** an understanding of the origin, significance, and grammatical foundations of Sanskrit, including Sandhi, Samasa, and Karaka, in relation to technical terminology.
CO2	**Interpret** technical vocabulary and root word derivations from Sanskrit related to mathematics, astronomy, architecture, and other scientific domains.
CO3	**Analyze** selected Sanskrit verses and texts to identify scientific and technical principles embedded in classical literature.
CO4	**Evaluate** the scientific concepts in Sanskrit literature such as mathematics in Shulba Sutras, medicine in Ayurveda, and astronomical ideas in Vedic texts.
CO5	**Apply** Sanskrit knowledge to relate ancient technical concepts to modern scientific terminology and frameworks, drawing insights from case studies and classical contributions.

Course Content:

Module 1: Fundamentals of Sanskrit and Technical Terminology [12L]:

Introduction to the origin and significance of Sanskrit in science and technology. Basic elements of Sanskrit grammar: Sandhi (word combination), Samasa (compounding), and Karaka (case relations). Vocabulary related to technical knowledge: mathematics, astronomy, and architecture. Understanding root words and derivations used in technical contexts. Reading and interpreting selected simple verses related to scientific principles.

Module 2: Sanskrit Literature and Technical Knowledge [12L]:

Overview of Sanskrit texts with scientific and technical relevance (e.g., Aryabhatiya, Charaka Samhita, Sushruta Samhita, Vastu Shastra). Study of concepts in mathematics (Shulba Sutras), medicine (Ayurveda), and astronomy. Technical knowledge in Sanskrit: energy, motion, time, and space in Vedic literature. Application of Sanskrit for understanding modern scientific terminology and concepts. Case studies highlighting contributions of Sanskrit to present-day knowledge systems.

Text Books:

1. The Astronomical Code of Rgveda. Subhash Kak. ISBN: 8121509866. Munshiram Manoharlal Publishers.
2. M. Rama Jois – Ancient Indian Tradition and Mythology: Scientific Heritage in Sanskrit Literature, Bharatiya Vidya Bhavan.
3. Kapil Kapoor – Dimensions of Panini Grammar: The Indian Grammatical System, D. K. Printworld.

Reference Books:

1. P. V. Kane – History of Sanskrit Poetics and Scientific Literature, Motilal Banarsidass.

2. Debiprasad Chattopadhyaya – Science and Society in Ancient India, Research India Publications.

3. Satya Prakash – Foundations of Indian Science: Concepts of Matter, Space, Time, and Motion in Ancient Thought, INSA.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	2	2
CO2	2	3	2	2	2
CO3	3	2	3	2	3
CO4	3	2	3	2	3
CO5	2	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Value Education

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** the nature, importance, and types of values and their role in character building, personality development, and achieving harmony of body, mind, and intellect.
CO2	**Analyze** ethical theories, moral philosophies, and values in relationships to strengthen trust, empathy, and professional responsibility.
CO3	**Demonstrate** an understanding of work ethics, discipline, punctuality, and integrity as essential qualities for leadership and effective decision-making.
CO4	**Apply** values to promote sustainable development, environmental protection, peace, and conflict resolution in personal and social contexts.
CO5	**Critically evaluate** case studies on value-based living and ethical dilemmas to integrate values into lifestyle for personal growth and professional excellence.

Course Content:

Module 1: Understanding Value Education [8L]:

Definition, nature, and importance of values. Types of values: personal, social, moral, spiritual, and universal values. Role of education in character building and personality development. Value crisis and the challenges in contemporary society. Harmony of the self: body, mind, and intellect.

Module 2: Human Values and Ethics [8L]:

Ethical theories and moral philosophies. Values in relationships: respect, trust, and empathy. Professional ethics and responsibilities. Work ethics, discipline, punctuality, and integrity. Role of values in developing leadership and decision-making abilities.

Module 3: Application of Values in Life [8L]:

Values for sustainable development and environmental protection. Non-violence, peace, and conflict resolution. Social responsibility and citizenship values. Case studies on value-based living and ethical dilemmas. Integration of values into lifestyle for personal and professional excellence.

Text Books:

1. R. R. Gaur, R. Sangal, & G. P. Bagaria – A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. Chakraborty, S. K. – Foundations of Managerial Work: Contributions from Indian Thought, Himalaya Publishing House.

Reference Books:

1. A. N. Tripathi – Human Values, New Age International.
2. D. R. Kiran – Professional Ethics and Human Values, McGraw Hill.
3. Rokeach, Milton – The Nature of Human Values, Free Press.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	1	3
CO2	3	2	3	2	2
CO3	2	3	3	1	3
CO4	3	2	3	2	2
CO5	3	2	3	2	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Advanced Database Management System Lab**
Course Code: **PCSM291**
Contact: **0:0:3**
Total Contact Hours: **36**
Credits: **1.5**

Prerequisites: Knowledge of basic DBMS concepts (ER modeling, SQL, normalization), data structures & algorithms, and programming in Java/Python.

Course Outcome(s): After completion of the course students will be able to

CO1	**Apply** basic, intermediate, and advanced SQL commands to retrieve, manipulate, and manage relational data.
CO2	**Design** Entity–Relationship (ER) models and normalize relational schemas to ensure consistency and minimize redundancy.
CO3	**Familiarize** students with NoSQL databases and Big Data query frameworks.
CO4	**Simulate and demonstrate** concurrency control and transaction management to ensure correctness and reliability in multi-user environments.
CO5	**Develop** skills for implementing database-backed applications and research-oriented database experiments.

Course Content:

Week 1: **Advanced SQL and Query Optimization[8L]:**

Writing complex SQL queries (nested queries, views, triggers, stored procedures, cursors), Query tuning with EXPLAIN/ANALYZE plans, Experiment on indexing (B+ tree, Hash indexes) and their impact on performance.

Week 2: **Database Design & Normalization [8L]:**

Case study: Design ER & EER models for real-world applications, Implement schema normalization (1NF to BCNF), Reverse engineering a schema from an existing dataset.

Week 3: **Transaction Management & Concurrency Control [6L]:**

Simulation of ACID properties, Implementation of locking protocols (2PL, timestamp ordering), Concurrency issues: deadlock, starvation – detection & resolution.

Week 4: **NoSQL & Big Data Databases [6L]:**

Introduction to NoSQL (MongoDB, Cassandra, Neo4j, Redis), Data modeling and CRUD operations in a NoSQL system, Running queries in Big Data frameworks (Apache Hive, Spark SQL).

Week 5: **Graph Database [8L]:**
Hands-on with graph databases (Neo4j – Cypher queries), Temporal and spatial databases.

Week 6: **Mini Project [12L]:**
Students will design and implement a mini-project using RDBMS + NoSQL/Big Data.

Text Books:

1. Elmasri & Navathe – Fundamentals of Database Systems (Pearson).
2. Silberschatz, Korth, Sudarshan – Database System Concepts (McGraw Hill).

Reference Books:

1. Hector Garcia-Molina, Ullman, Widom – Database Systems: The Complete Book.
2. Kristina Chodorow – MongoDB: The Definitive Guide.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	3	2
CO2	3	3	3	3	2
CO3	2	2	2	3	3
CO4	3	3	3	2	2
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: Data Science and Visualization Lab
Course Code: PCSM292
Contact: 0:0:3
Total Contact Hours: 36
Credits: 1.5

Prerequisites:

- Basic programming knowledge in Python (variables, data types, loops, functions, and data structures).
- Fundamental understanding of statistics (mean, median, standard deviation, distributions, probability).
- Familiarity with spreadsheets or tabular data formats (CSV, Excel) is helpful but not mandatory.

Course Outcome(s): After completion of the course students will be able to

CO1	**Demonstrate** proficiency in data collection, handling, and exploration using structured and unstructured datasets.
CO2	**Apply** data preprocessing, cleaning, and transformation techniques to prepare datasets for analysis.
CO3	**Develop** and interpret data visualizations using Python libraries to identify patterns, trends, and insights.
CO4	**Perform** exploratory data analysis (EDA) and statistical evaluations to support decision-making and data-driven storytelling.
CO5	**Integrate** advanced visualization techniques and present an end-to-end data science workflow, including analysis and interactive visualizations, in a professional report or project presentation.

Course Content:

Week 1: Introduction to Data Science Environment:

Setting up the environment, working with notebooks; Loading datasets in different formats (CSV, JSON, Excel, databases); Basic Python refresher: lists, dictionaries, data frames.

Week 2: Data Collection and Exploration:

Importing datasets from files and APIs; Simple web scraping exercise; Descriptive statistics: mean, median, standard deviation, distributions.

Week 3: Handling Missing and Duplicate Data:

Identifying missing values, duplicates, and outliers; Strategies for imputation and cleaning; Practical exercise on a real-world dataset.

Week 4: Data Transformation and Feature Engineering:

Encoding categorical variables; Scaling and normalization; Creating new features from existing data.

Week 5: Data Integration and Time/Text Handling:

Merging and joining multiple datasets; Basics of handling time-series data; Simple preprocessing of text data.

Week 6: Visualization with Matplotlib (Part I):

Line, bar, histogram, and pie charts; Customizing plots with labels, colors, legends, and annotations.

Week 7: Visualization with Matplotlib (Part II):

Subplots and multiple graphs; Practical visualization tasks with real data.

Week 8: Visualization with Seaborn (Part I):

Statistical plots: boxplot, violin plot, scatter, pairplot; Plot customization for better readability.

Week 9: Visualization with Seaborn (Part II):

Advanced plots: heatmaps, categorical plots; Visualizing time-series and trends.

Week 10: Exploratory Data Analysis (EDA):

Correlation analysis and relationships between variables; Step-by-step EDA on a case study dataset; Storytelling with plots.

Week 11: Advanced Visualization Applications:

Geographic visualizations (maps); Network and hierarchical data visualization; Visualizing results from simple machine learning models.

Week 12: Final Project Presentation:

End-to-end workflow: data collection, preprocessing, visualization, and EDA; Presentation of findings using visual storytelling.

Text Books:

1. Introduction to Data Science:Practical Approach with R and Python. B. Uma Maheswari and R. Sujatha. ISBN: 9354640508. Wiley.
2. Data Science From Scratch: First Principles with Python. Joel Grus. ISBN: 9352138325. Shroff/O'Reilly.

Reference Books:

1. Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures. Claus O. Wilke. ISBN: 9352138112. Shroff/O'Reilly.
2. Data Visualization: Storytelling Using Data. Sharada Sringeswara; Purvi Tiwari; U. Dinesh Kumar. ISBN: 9354643132. Wiley.

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	3	3
CO2	3	3	3	3	2
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Course Name: **Mini Project with Seminar**
Course Code: **CSM281**
Contact: **0:0:3**
Total Contact Hours: **3**
Credits: **1.5**

Course Outcome(s): After completion of the course students will be able to

CO1	Formulate a research or application-oriented problem statement in the domain of Computer Science and Engineering.
CO2	Conduct literature survey and identify appropriate methodologies, tools, and technologies for project development.
CO3	Demonstrate the ability to design, implement, and analyze a mini project individually or as part of a team.
CO4	Present and defend the project work effectively through seminars, technical documentation, and viva-voce.
CO5	Develop professional skills including independent learning, technical communication, and project management, laying a foundation for dissertation and industry internship.

General Guidelines:

- The **Mini Project with Seminar** in the second semester of the M.Tech (CSE) program provides students with the opportunity to carry out research-oriented or application-oriented work in their chosen area of specialization.
- The project work can be pursued either under the guidance of an **internal departmental faculty member** or in collaboration with **industry, R&D organizations, startups, or academic institutions**.
- Students intending to carry out their project in an industry, startup, or R&D organization **must obtain prior approval/consent from the department**.
- For projects carried out in industry, each student would be assigned at least two supervisors:
  - one faculty supervisor from the department, and
  - one supervisor/mentor from the industry.

Synopsis Submission and Seminar:

- Each students are required to select a project topic and submit a **synopsis** outlining the objectives, scope, and methodology of the project.
- Each student is required to deliver a **seminar presentation** of the project synopsis before the Board of Examiners for approval and feedback.
- The approved project is to be carried out during the semester under the supervision of the assigned guide/mentor.

R-25 Curriculum for Master of Technology (M.Tech)

Department of Computer Science & Engineering (CSE)

Narula Institute of Technology

Evaluation and Mark Distribution:

The evaluation of the mini project will be based on continuous assessment, seminar presentation, and final evaluation by the committee. The distribution of marks are as follows:

1. Projects under Industry / External Organization

- The **industry mentor** will be requested to provide an evaluation of the student's performance.
- If such marks are available, they will carry a **40% weight** of the total marks.
- The remaining **60% weight** will be awarded by the **departmental evaluation committee** based on the student's presentation and viva-voce.
- If industry marks are not available, then total evaluation will be carried out by the committee.

2. Projects under Internal Faculty Supervision

- The **internal faculty guide** will award **40% of the total marks**.
- The remaining **60% marks** will be given by the **departmental evaluation committee** after the seminar presentation and viva-voce.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	2	1
CO2	2	3	2	2	3
CO3	3	2	3	3	2
CO4	1	3	2	1	1
CO5	2	3	2	2	3

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3rd Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Sessional				L T P	Total	
1	Audit-II	CSM301	**Audit Course-II:** 1. Constitution of India 2. Pedagogy Studies 3. Stress Management by Yoga 4. Personality Development through Life Enlightenment Skills	2-0-0	2	0
B. Practical						
2	Project	CSM391	Dissertation-I / Industry Internship	0-0-20	20	10
Total				**2-0-20**	**22**	**10**

L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]

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Course Name: Audit Course-II
Course Code: CSM301
Contact: 2:0:0
Total Contact Hours: 24
Credits: 2

Subjects to Choose

1. Constitution of India
2. Pedagogy Studies
3. Stress Management by Yoga
4. Personality Development through Life Enlightenment Skills

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Constitution of India

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** the historical background, philosophy, and salient features of the Indian Constitution.
CO2	**Interpret** Fundamental Rights, Duties, and Directive Principles in relation to social and professional responsibilities.
CO3	**Analyze** the structure and functioning of the Union, State Governments, and Judiciary with reference to governance.
CO4	**Evaluate** the role of constitutional bodies, emergency provisions, and amendments in ensuring democracy and accountability.
CO5	**Apply** constitutional provisions and legal frameworks (IT Act, Cyber Laws, RTI) to issues in science, technology, and computing.

Course Content:

Module 1: Introduction and Basic Framework [8L]:

Historical background, making of the Constitution, role of Constituent Assembly, Preamble and salient features of the Constitution, Fundamental Rights and Duties: scope, significance, and limitations, Directive Principles of State Policy (DPSP): objectives and relation with Fundamental Rights

Module 2: Structure, Governance, and Constitutional Bodies [8L]:

Union Government: President, Prime Minister, Parliament, Council of Ministers, State Government: Governor, Chief Minister, State Legislature, Judiciary: Supreme Court, High Courts, Judicial Review and Activism, Federal system: Centre–State relations, Inter-State coordination, Constitutional bodies: Election Commission, Finance Commission, UPSC, CAG

Module 3: Application to Science, Technology, and Society [8L]:

Emergency provisions and constitutional amendments, Provisions relating to Science & Technology, IT Act, Cyber Laws, and Intellectual Property Rights, Right to Information Act (RTI) and digital governance, Case studies: Constitutional values in technology, data privacy, e-democracy, digital rights

Text Books:

1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, Latest Edition.
2. M. Laxmikanth, Indian Polity, McGraw Hill Education, Latest Edition.
3. J.N. Pandey, The Constitutional Law of India, Central Law Agency, Latest Edition.

Reference Books:

1. P.M. Bakshi, The Constitution of India, Universal Law Publishing.
2. Granville Austin, The Indian Constitution: Cornerstone of a Nation, Oxford University Press.
3. Relevant Acts: IT Act 2000 (with amendments), RTI Act 2005, Copyrights and IPR Acts.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	1	2
CO2	2	3	2	2	2
CO3	3	2	3	1	3
CO4	3	2	3	1	2
CO5	3	2	3	3	1

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Pedagogy Studies

Course Outcome(s): After completion of the course students will be able to

CO1	**Explain** the fundamentals of pedagogy, teaching-learning theories, and their application in higher education.
CO2	**Design** curriculum and instructional strategies tailored to Computer Science and Engineering courses.
CO3	**Integrate** ICT tools, e-learning platforms, and innovative methods to enhance student learning.
CO4	**Develop** effective assessment and evaluation techniques aligned with Outcome-Based Education.
CO5	**Analyze and apply** modern pedagogical innovations to improve teaching effectiveness and research in engineering education.

Course Content:

Module 1: Foundations of Pedagogy [8L]:

Meaning, nature, and scope of pedagogy, Concepts of teaching, learning, and instruction, Bloom's Taxonomy: Cognitive, Affective, and Psychomotor domains, Teaching methods: Lecture, Discussion, Demonstration, Problem-Based Learning, Pedagogical approaches for higher education and professional courses in Computer Science

Module 2: Curriculum Design and Teaching-Learning Processes [8L]:

Principles of curriculum design and instructional objectives, Designing learning outcomes and mapping with assessments, ICT-enabled teaching, e-learning platforms, MOOCs, flipped classrooms, Student engagement techniques: collaborative learning, peer instruction, and mentoring, Pedagogy for programming, algorithms, data science, and emerging technologies

Module 3: Assessment, Evaluation, and Pedagogical Innovations [8L]:

Principles and tools of student assessment and evaluation, Formative vs. Summative assessment; rubrics and feedback mechanisms, Outcome-Based Education (OBE) framework and accreditation perspectives (NBA/NAAC), Innovative teaching practices in engineering education: project-based learning, case studies, experiential learning, Research in pedagogy: evaluating effectiveness, reflective teaching practices

Text Books:

1. Bruner, J. – The Process of Education, Harvard University Press.
2. Bloom, B. S. – Taxonomy of Educational Objectives: The Classification of Educational Goals.
3. Joyce, B., Weil, M., & Calhoun, E. – Models of Teaching, Pearson Education.

Reference Books:

1. Biggs, J., & Tang, C. – Teaching for Quality Learning at University, McGraw Hill Education.
2. Ramsden, P. – Learning to Teach in Higher Education, Routledge.
3. Korthagen, F. – Linking Practice and Theory: Pedagogy of Realistic Teacher Education, Routledge.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	2	2
CO2	3	3	3	3	2
CO3	2	3	3	3	3
CO4	3	3	3	3	2
CO5	2	2	3	3	3

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Stress Management by Yoga

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the concepts of stress, its causes, and its impact on health and performance.
CO2	**Demonstrate** basic yogic practices (asanas, pranayama, meditation) for stress reduction.
CO3	**Apply** yoga-based techniques to manage academic, workplace, and personal stress.
CO4	**Evaluate** the effectiveness of yoga and mindfulness practices for holistic well-being.
CO5	**Design** and follow a personalized stress management plan incorporating yoga.

Course Content:

Module 1: Introduction to Stress and Yoga [8L]:

Definition and types of stress: eustress, distress, Causes of stress in modern life (academic, professional, social, and personal), Physiological, psychological, and behavioral impact of stress, Concept of Yoga: history, philosophy, and relevance in stress management, Relationship between mind, body, and breath

Module 2: Yogic Practices for Stress Reduction [8L]:

Asanas (Postures): Standing, Sitting, Supine, and Prone postures for relaxation, Pranayama (Breathing techniques): Anulom-Vilom, Bhramari, Kapalbhati, Sheetali, Sheetkari, Meditation and Mindfulness: Dharana, Dhyana, and relaxation techniques, Guided Yoga Nidra for stress release, Lifestyle management: Yogic diet, discipline, and daily routine (Dinacharya)

Module 3: Application of Yoga in Professional and Academic Life [8L]:

Role of Yoga in emotional intelligence, concentration, and memory enhancement, Yoga for workplace stress, digital fatigue, and mental well-being, Case studies: Yoga interventions for students, teachers, and professionals, Integration of yoga with modern stress management techniques (CBT, relaxation therapy), Designing a personalized yoga-based stress management routine

Text Books:

1. Swami Satyananda Saraswati – Asana, Pranayama, Mudra, Bandha, Bihar School of Yoga.
2. Swami Vivekananda – Raja Yoga, Advaita Ashrama Publication.
3. Dr. H. R. Nagendra – Yoga for Stress Management, Swami Vivekananda Yoga Publications.

Reference Books:

1. B.K.S. Iyengar – Light on Yoga, HarperCollins.
2. T.K.V. Desikachar – The Heart of Yoga: Developing a Personal Practice.
3. N.K. Gupta – Stress Management through Yoga and Meditation.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	1	1
CO2	2	2	1	2	1
CO3	3	2	2	3	2
CO4	2	3	2	2	2
CO5	3	3	2	3	2

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Personality Development through Life Enlightenment Skills

Course Outcome(s): After completion of the course students will be able to

CO1	**Understand** the concept of personality and factors contributing to its development.
CO2	**Apply** self-awareness and emotional intelligence techniques for personal growth.
CO3	**Practice** life skills and stress management methods inspired by ancient wisdom and modern psychology.
CO4	**Demonstrate** effective communication, leadership, and teamwork abilities.
CO5	**Integrate** personality development and life enlightenment skills for professional excellence and social harmony.

Course Content:

Module 1: Foundations of Personality Development [8L]:

Concept and dimensions of personality: physical, mental, emotional, and social, Factors influencing personality: heredity, environment, education, and self-effort, Self-awareness: self-analysis, strengths and weaknesses, emotional intelligence, Positive thinking, attitude building, and motivation, Role of values and ethics in shaping personality

Module 2: Life Enlightenment Skills [8L]:

Ancient wisdom and modern perspectives on life skills, Lessons from Bhagavad Gita, Upanishads, and teachings of great leaders, Stress management and inner peace through yoga and meditation, Time management, decision-making, and problem-solving skills, Emotional balance, resilience, and conflict resolution

Module 3: Applied Personality and Professional Skills [8L]:

Communication skills: verbal, non-verbal, and active listening, Leadership, teamwork, and interpersonal relationship building, Creativity, innovation, and adaptability in professional life, Goal setting, career planning, and self-discipline, Case studies: Role of enlightened personality in professional success and societal well-being

Text Books:

1. Swami Vivekananda – Personality Development.
2. S.K. Bhatia – Personality Development and Soft Skills.

Reference Books:

1. Stephen Covey – The 7 Habits of Highly Effective People.
2. Dale Carnegie – How to Win Friends and Influence People.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	1	1
CO2	2	3	2	2	1
CO3	3	2	2	2	1
CO4	3	3	3	2	1
CO5	3	3	3	3	2

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Course Name: Dissertation-I / Industry Internship
Course Code: CSM391
Contact: 0:0:20
Total Contact Hours: 20
Credits: 10

CO1	**Demonstrate** the ability to independently plan and execute research or development projects under the guidance of a faculty supervisor or industry mentor, applying structured problem-solving techniques.
CO2	**Develop** proficiency in technical documentation by preparing monthly progress reports and a comprehensive semester report while adhering to ethical research and data practices.
CO3	**Apply** theoretical knowledge to practical scenarios in industry or academic research environments, gaining hands-on experience in project execution and result analysis.
CO4	**Communicate** technical concepts effectively through progress seminars and presentations, demonstrating the ability to convey project outcomes and insights clearly.
CO5	**Evaluate** and reflect on project outcomes using continuous feedback from supervisors and mentors, ensuring compliance with plagiarism and ethical standards in research.

Introduction:

The **Dissertation–I / Industry Internship** in the third semester of the M.Tech (CSE) program is intended to provide students with hands-on exposure to research and development activities either in the department under a faculty supervisor or in collaboration with industry, R&D organizations, startups, or academic institutions. The objective is to initiate the student into structured research and project execution that will be carried forward into **Dissertation–II / Industry Internship** in the final semester.

General Instructions:

- Regular interaction with the assigned **faculty supervisor** is mandatory.
- Students are required to submit **progress reports** on monthly basis (or as per departmental notification).
- A **mid-term evaluation** will be conducted to assess progress, problem understanding, and initial results.
- At the end of the semester, each student is required to appear for a **progress seminar** before the evaluation committee along with the progress report.
- The students are required to ensure that the similarity index of the project report remains within 15%.
- Students must strictly follow **ethical practices** in research, programming, data collection, and result reporting.

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Evaluation and Mark Distribution:

The evaluation of Dissertation–I / Industry Internship will be based on continuous assessment, supervisor/mentor evaluation, and final presentation. The marks will be distributed as follows:

1. Projects in Industry / External Organizations

- The **industry mentor** will be requested to provide an evaluation of the student's performance.
- If such marks are available, they will carry a **40% weight** of the total marks.
- The remaining **60% marks** will be awarded by the **departmental evaluation committee** based on the seminar presentation and report.
- If industry marks are not available, then total evaluation will be carried out by the committee.

2. Projects under Internal Faculty Supervision

- The **internal faculty supervisor** will award **40% of the total marks**.
- The remaining **60% marks** will be awarded by the **departmental evaluation committee** based on the seminar presentation and report.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	2	1
CO2	2	3	2	1	2
CO3	3	1	3	3	1
CO4	1	3	2	1	1
CO5	3	2	2	1	2

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4th Semester

Sl No.	Course Type	Course Code	Course Title	Hours per Week		Credits
A. Practical				L T P	Total	
1	Skill	CSM491	Comprehensive Viva Voce	0-0-0	0	4
2	Project	CSM492	Dissertation-II / Industry Internship	0-0-32	32	16
Total				**0-0-32**	**32**	**20**

Total Credit: 68

****L – Lecture; T– Tutorial; P– Practical [1L=1Cr, 1T=1Cr, 1P=0.5Cr]***

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Course Name: Dissertation-II / Industry Internship
Course Code: CSM492
Contact: 0:0:32
Total Contact Hours: 32
Credits: 16

CO1	**Demonstrate** the ability to independently carry out research, system design, implementation, and analysis in the field of Computer Science and Engineering.
CO2	**Develop** a high-quality and original dissertation report, including problem definition, literature review, methodology, results, and conclusions, while adhering to ethical and plagiarism standards.
CO3	**Apply** advanced technical knowledge and research skills to solve real-world problems, including design, coding, and data analysis.
CO4	**Communicate** research findings effectively through presentations, demonstrations, viva-voce, and supplementary documentation such as source code or datasets.
CO5	**Evaluate** research outcomes critically and demonstrate innovation through potential publications, patents, prototypes, or other tangible results.

Introduction:

The **Dissertation–II / Industry Internship** in the fourth semester of the M.Tech (CSE) program represents the culmination of the research or project work initiated in **Dissertation–I**. It is intended to demonstrate the student's ability to carry out independent research, system design, implementation, and analysis in the domain of Computer Science and Engineering.

General Instructions:

- Students are required to maintain regular interaction with the internal faculty supervisor and keep proper documentation of their work.
- At the end of the semester, each student must submit a **final project report (dissertation)** as per the prescribed format.
- The students are required to ensure that the similarity index of the project report remains within 15%.
- Students are to follow **ethical practices** in research, coding, data collection, and result reporting.

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Evaluation and Mark Distribution:

The evaluation of Dissertation–II / Industry Internship will be carried out entirely by the **departmental evaluation committee** based on the following:

- Quality and originality of the final dissertation report.
- Problem definition, objectives, and review of literature.
- Methodology, system design/implementation, and results.
- Final presentation, demonstration, and viva-voce.
- Research outcomes such as publications, patents, or prototypes (if any).

Submission Requirements:

- Three hard copies of the final dissertation report duly signed by the student, supervisor(s), and head of the department. The report format will be provided by the department and have to adhare strictly.
- soft copy of the dissertation report in PDF format.
- A plagiarism check certificate (with acceptable similarity index).
- Any supplementary material (datasets, source code, or software tools) if applicable.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	2
CO2	1	3	2	2	1
CO3	3	2	3	3	3
CO4	2	3	2	2	1
CO5	3	2	3	3	2