Faculty of Science, Technology and Architecture | School of CSE & IT

Department of CSE

SCHOOL OF CSE & IT

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

MASTER OF TECHNOLOGY COMPUTER SCIENCE AND ENGINEERING

COURSE STRUCTURE

(Session: 2025-26)

Faculty of Science, Technology and Architecture | School of CSE & IT

Department of CSE

Course Structure
M.Tech.: Computer Science and Engineering
Academic Session: 2025 – 2026
Duration: 2 Years, Total Number of Credits: 80

Year	FIRST SEMESTER						SECOND SEMESTER					
	Course Code	Course Name	L	T	P	C	Course Code	Course Name	L	T	P	C
I	CSE6101	Computational Mathematics	4	0	0	4	CSE6201	Advanced Database Management Systems	3	0	2	4
	CSE6102	Advanced Data Structures and Algorithms	3	0	2	4	CSE6202	Advanced Programming Paradigm	3	0	2	4
	CSE6103	Artificial Intelligence	3	0	2	4	CSE6203	Advanced Computer Networks	3	0	2	4
	CSE6104	Research Methodologies	4	0	0	4	CSE62XX	Program Elective III	4	0	0	4
	CSE61XX	Program Elective I	4	0	0	4	CSE62XX	Program Elective IV	4	0	0	4
	CSE61XX	Program Elective II	4	0	0	4	CSE62XX	Program Elective V	4	0	0	4
							CSE6270	Research Project	-	-	-	2
	Total Credits					**24**	Total Credits					**26**
II	THIRD SEMESTER						FOURTH SEMESTER					
	CSE7170	Dissertation I	-	-	-	15	CSE7270	Dissertation II	-	-	-	15
	Total Credits					**15**	Total Credits					**15**

Program Elective I	Program Elective II
CSE6140: Applied Cryptography CSE6141: Machine Learning	CSE6150: Cybersecurity Tools & Cyberattacks CSE6151: Computer Vision
Program Elective III	**Program Elective IV**
CSE6240: Digital Forensics CSE6241: Reinforcement Learning	CSE6250: Blockchain Technology CSE6251: Generative AI

Program Elective V
CSE6261: Quantum Computing CSE6262: Natural Language Processing CSE6263: Social Networks Analysis CSE6264: Recommender Systems CSE6265: Cloud Infrastructure and Virtualization CSE6266: Malware Analysis and Intrusion Detection

Course: Computational Mathematics **Course code:** CSE6101
Core/Program Elective/Open Elective/Lab: Core
Course Outcomes: At the end of the course, students will be able to

CSE6101.1. Explain and interpret core concepts in linear algebra, probability, and optimization. **[L2, Understand]**
CSE6101.2. Apply numerical methods to solve equations, interpolation, and data fitting in computational setups. **[L3, Apply]**
CSE6101.3. Analyse convergence, stability, and error in numerical algorithms used in AI/ML. **[L4, Analyse]**
CSE6101.4. Evaluate probabilistic models and perform statistical inference relevant to Computer. **[L5, Evaluate]**
CSE6101.5. Design and implement system and verified using hybrid machines. **[L3, Apply]**

Course: Advanced Data Structures and Algorithms **Course code:** CSE6102
Core/Program Elective/Open Elective/Lab: Core
Course Outcomes: At the end of the course, students will be able to

CSE6102.1. Demonstrate efficiency in analysing the time and space complexity of algorithms. **[L4, Analyse]**
CSE6102.2. Identify and apply appropriate algorithmic structures to solve problems across various engineering domains. **[L3, Apply]**
CSE6102.3. Gain knowledge of state-of-the-art advancements and trends in the field of algorithms. **[L2, Understand]**

Course: Artificial Intelligence **Course code:** CSE6103
Core/Program Elective/Open Elective/Lab: Core
Course Outcomes: At the end of the course, students will be able to

CSE6103.1. Understand the concept of artificial intelligence. **[L2, Understand]**
CSE6103.2. Analyze and implement problem-solving search strategies. **[L4, Analyse]**
CSE6103.3. Implement knowledge-based systems using logic and inference. **[L3, Apply]**
CSE6103.4. Apply classical planning techniques to AI problems. **[L3, Apply]**
CSE6103.5. Design intelligent agents and apply AI techniques to real-world problems. **[L3, Apply]**

Course: Applied Cryptography **Course code:** CSE6140
Core/Program Elective/Open Elective/Lab: Program Elective-1
Course Outcomes: At the end of the course, students will be able to

CSE6140.1. Make use of mathematical structures such as modular arithmetic, finite fields, and number theoretic algorithms. **[L3, Apply]**
CSE6140.2. Use symmetric and asymmetric cryptographic primitives to develop secure communication systems. **[L3, Apply]**
CSE6140.3. Apply cryptographic hash functions, message authentication codes, and digital signature techniques to ensure integrity and authentication in digital communications. **[L3, Apply]**
CSE6140.4. Analyse cryptographic protocols deployed in real-world applications (e.g., TLS, Signal, AWS) to identify potential vulnerabilities and assess implementation correctness. **[L4, Analyse]**
CSE6140.5. Compare and contrast classical cryptographic techniques with post-quantum schemes based on security properties and performance trade-offs. **[L4, Analyze]**

Course: Machine Learning **Course code:** CSE6141

Core/Program Elective/Open Elective/Lab: Program Elective-1

Course Outcomes: At the end of the course, students will be able to

CSE6141.1. Understand and implement key ML algorithms. **[L2, Understand]**
CSE6141.2. Evaluate models using statistical metrics.**[L5, Evaluate]**
CSE6141.3. Develop and Implement scalable and generalizable models. **[L3, Apply]**
CSE6141.4. Apply ML to classification, regression, and clustering tasks. **[L3, Apply]**

Course: Cybersecurity Tools & Cyberattacks **Course code:** CSE6150

Core/Program Elective/Open Elective/Lab: Program Elective-2

Course Outcomes: At the end of the course, students will be able to

CSE6150.1. Identify and classify different types of cyberattacks and security threats. **[L2, Understand]**
CSE6150.2. Apply various cybersecurity tools to analyse vulnerabilities in systems. **[L3, Apply]**
CSE6150.3. Design and simulate network attacks and propose mitigation strategies. **[L3, Apply]**
CSE6150.4. Perform penetration testing using standard toolkits and methodologies. **[L3, Apply]**
CSE6150.5. Evaluate security risks and develop secure configurations for systems. **[L5, Evaluate]**

Course: Computer Vision **Course code:** CSE6151

Core/Program Elective/Open Elective/Lab: Program Elective-2

Course Outcomes: At the end of the course, students will be able to

CSE6151.1. Understand image formation, digital cameras, and the scope of computer vision. **[L2,Understand]**
CSE6151.2. Apply diverse image processing techniques for manipulation and enhancement. **[L3, Apply]**
CSE6151.3. Analyse and implement feature detection, image alignment, and motion estimation. **[L4, Analyse]**
CSE6151.4. Evaluate methods for depth estimation and various recognition tasks. **[L5, Evaluate]**
CSE6151.5. Design and utilize deep learning models for real-world computer vision applications. **[L5, Evaluate]**

Course: Advanced Database Management Systems **Course code:** CSE6201

Core/Program Elective/Open Elective/Lab: Core

Course Outcomes: At the end of the course, students will be able to

CSE6201.1. Understand the concepts of advance database design. **[L2,Understand]**
CSE6201.2. Design and optimize complex database queries and applications. **[L3, Apply]**
CSE6201.3. Evaluate and use NoSQL databases effectively. **[L5, Evaluate]**
CSE6201.4. Analyse and work with distributed and parallel databases. **[L4, Analyse]**
CSE6201.5. Apply concepts from current research to real-world problems. **[L3, Apply]**

Course: Advanced Programming Paradigm **Course code:** CSE6202
Core/Program Elective/Open Elective/Lab: Core
Course Outcomes: At the end of the course, students will be able to

- CSE6202.1. Explain the meaning of a computational model during implementation. **[L2,Understand]**
- CSE6202.2. Apply an idea of modern application of data structures and algorithms. **[L3, Apply]**
- CSE6202.3. Implement networking protocols through small systems. **[L3, Apply]**
- CSE6202.4. Evaluate the ability to work in parallel platforms. **[L5, Evaluate]**
- CSE6202.5. Apply principles of distributed systems in practical implementations. **[L3, Apply]**

Course: Advanced Computer Networks **Course code:** CSE6203
Core/Program Elective/Open Elective/Lab: Core
Course Outcomes: At the end of the course, students will be able to

- CSE6203.1. Analyse and compare advanced routing protocols and algorithms used in large networks. **[L4, Analyse]**
- CSE6203.2. Evaluate high-speed networking protocols and techniques including QoS and MPLS. **[L5, Evaluate]**
- CSE6203.3. Understand the architecture and operation of Software Defined Networks (SDNs). **[L2,Understand]**
- CSE6203.4. Analyse and design data centre network topologies and their performance implications. **[L4, Analyse]**
- CSE6203.5. Implementation and analyse the advance topology and programable network. **[L4, Analyse]**

Course: Digital Forensics **Course code:** CSE6240
Core/Program Elective/Open Elective/Lab: Program Electicve-3
Course Outcomes: At the end of the course, students will be able to

- CSE6240.1. Explain the importance of digital forensics in the context of modern cybersecurity and criminal investigations. **[L2,Understand]**
- CSE6240.2. Identify various digital forensic operandi and motive behind cyber-attacks. **[L3, Apply]**
- CSE6240.3. Interpret the cyber pieces of evidence, Digital forensic process model and their legal perspective. **[L2,Understand]**
- CSE6240.4. Make use of various forensic tools to investigate the cybercrime and to identify the digital pieces of evidence. **[L3, Apply]**
- CSE6240.5. Analyse the digital evidence used to commit cyber offenses. **[L4, Analyse]**

Course: Reinforcement Learning **Course code:** CSE6241
Core/Program Elective/Open Elective/Lab: Program Electicve-3
Course Outcomes: At the end of the course, students will be able to

CSE6241.1. Explain fundamental reinforcement learning concepts including MDPs, value functions, and dynamic programming methods. **[L2,Understand]**
CSE6241.2. Apply tabular RL algorithms (Monte Carlo, TD Learning, Q-Learning) and function approximation methods (DQN, Policy Gradients) to solve standard reinforcement learning problems. **[L3, Apply]**
CSE6241.3. Analyse different RL approaches by evaluating their performance characteristics on benchmark environments. **[L4, Analyse]**
CSE6241.4. Evaluate and assess advanced RL techniques by examining their strengths and limitations in solving complex real-world problems. **[L5, Evaluate]**
CSE6241.5. Design and develop RL solutions for practical applications (games, robotics, NAS) while considering ethical implications and safety constraints in the solution architecture. **[L3, Apply]**

Course: Blockchain Technology **Course code:** CSE6250
Core/Program Elective/Open Elective/Lab: Program Electicve-4
Course Outcomes: At the end of the course, students will be able to

CSE6250.1. Understand the fundamentals of Blockchain architecture, components, and its working principles. **[L2,Understand]**
CSE6250.2. Analyse various consensus mechanisms and their applicability in different Blockchain platforms. **[L4, Analyse]**
CSE6250.3. Design and implement smart contracts using platforms like Ethereum. **[L3, Apply]**
CSE6250.4. Apply Blockchain in various domains such as finance, healthcare, and supply chain. **[L3, Apply]**
CSE6250.5. Evaluate security, privacy, and scalability issues in Blockchain systems. **[L5, Evaluate]**

Course: Generative AI **Course code:** CSE6251
Core/Program Elective/Open Elective/Lab: Program Electicve-4
Course Outcomes: At the end of the course, students will be able to

CSE6251.1. Explain foundational concepts and models of generative artificial intelligence. **[L2,Understand]**
CSE6251.2. Implement generative models such as GANs, VAEs, and diffusion models to generate realistic data. **[L3, Apply]**
CSE6251.3. Demonstrate applications of generative AI in natural language processing, computer vision, and multimedia generation. **[L3, Apply]**
CSE6251.4. Evaluate and interpret generative model outputs using quantitative and qualitative metrics. **[L5, Evaluate]**
CSE6251.5. Analyse ethical considerations and societal impacts associated with generative AI technologies. **[L4, Analyse]**

Course: Quantum Computing **Course code:** CSE6261
Core/Program Elective/Open Elective/Lab: Program Electicve-5
Course Outcomes: At the end of the course, students will be able to

CSE6261.1. Explain foundational principles of quantum measurements, entanglement, and quantum information theory. **[L2,Understand]**
CSE6261.2. Apply quantum algorithms, gates, and circuits to solve computational problems. **[L3, Apply]**
CSE6261.3. Demonstrate understanding of quantum error correction, fault tolerance, and quantum cryptography. **[L2,Understand]**
CSE6261.4. Analyse various quantum hardware implementations and address issues of scalability and fidelity. **[L4, Analyse]**
CSE6261.5. Evaluate the potential and limitations of contemporary quantum technologies and predict future advancements. **[L5, Evaluate]**

Course: Natural Language Processing **Course code:** CSE6262
Core/Program Elective/Open Elective/Lab: Program Electicve-5
Course Outcomes: At the end of the course, students will be able to

CSE6262.1. Explain the fundamental concepts and techniques of natural language processing. **[L2,Understand]**
CSE6262.2. Describe the relation between parts of speech and grammatical structures used for any natural language with key concepts of NLP. **[L2,Understand]**
CSE6262.3. Analyse and demonstrate various lexical and semantic based text representation methods in terms of language understanding. **[L4, Analyse]**
CSE6262.4. Analyse the NLP models for word sense and discourse analysis in terms of natural language expression. **[L4, Analyse]**
CSE6262.5. Evaluate topic coherence and interpretability using suitable metrics and visualisation techniques. **[L5, Evaluate]**

Course: Social Networks Analysis **Course code:** CSE6263
Core/Program Elective/Open Elective/Lab: Program Electicve-5
Course Outcomes: At the end of the course, students will be able to

CSE6263.1. Explain foundational concepts of social-network analysis, including node-edge semantics, real-world network properties, and common layout paradigms. **[L2,Understand]**
CSE6263.2. Apply quantitative network measures as centralities, clustering, transitivity, similarity to describe and interpret structural roles in empirical graphs. **[L3, Apply]**
CSE6263.3. Analyse and implement community-detection and evolution techniques (Girvan-Newman, Louvain, Label Propagation, stochastic block models) and assess their validity with modularity, NMI and related metrics. **[L4, Analyse]**
CSE6263.4. Evaluate link-prediction and recommendation approaches, comparing similarity indices, path-based scores and supervised classifiers under cold-start and sparsity constraints. **[L5, Evaluate]**
CSE6263.5. Design graph-representation-learning pipelines (DeepWalk, Node2Vec, GCNs) and synthesize influence-maximization or outbreak-detection solutions for real-world social-network applications. **[L5, Evaluate]**

Course: Recommender Systems **Course code:** CSE6264

Core/Program Elective/Open Elective/Lab: Program Electicve-5

Course Outcomes: At the end of the course, students will be able to

CSE6264.1. Define the fundamental concepts, architecture, and types of recommender systems; explain the need and role of personalization in modern applications. **[L2, Understand]**

CSE6264.2. Distinguish between collaborative, content-based, and hybrid recommendation techniques and illustrate the structure and logic of user-based and item-based filtering methods. **[L4, Analyse]**

CSE6264.3. Construct user profiles and item representations for content-based recommendations; apply similarity measures to retrieve relevant items using content and behavioural data. **[L3, Apply]**

CSE6264.4. Analyse neighbourhood-based, constraint-based, and context-aware recommender systems; compare the advantages and limitations of each method in various application domains. **[L4, Analyse]**

CSE6264.5. Evaluate recommender systems using offline metrics such as RMSE, MAE, precision, and ranking-based measures; assess the impact of cold-start, long-tail effects, and data drift on system performance. **[L5, Evaluate]**

Course: Cloud Infrastructure and Virtualization **Course code:** CSE6265

Core/Program Elective/Open Elective/Lab: Program Electicve-5

Course Outcomes: At the end of the course, students will be able to

CSE6265.1. Understand and analyse the architecture of cloud computing systems. **[L4, Analyse]**

CSE6265.2. Demonstrate knowledge of cloud service models and architectural design challenges. **[L2, Understand]**

CSE6265.3. Apply knowledge of distributed systems and virtualization to cloud environments. **[L3, Apply]**

CSE6265.4. Utilize industry-standard cloud platforms and tools for development and deployment. **[L3, Apply]**

CSE6265.5. Understand and evaluate virtualization platforms and their integration with cloud. **[L2, Understand]**

Course Code: -	**CSE6101**	**Course Name: -**	**Computational Mathematics**
Semester: -	**1**	**Branch Name: -**	**CSE**
Course Type: -	**Core**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6101: Computational Mathematics **[4 0 0 4]**

Course Contents

Linear Algebra Refresher: Vector spaces, basis, and dimension, Eigenvalues, eigenvectors, SVD, Matrix norms and conditioning, Application: PCA and dimensionality reduction; **Numerical Computation:** Root finding: Bisection, Newton-Raphson, Interpolation and curve fitting: Lagrange, Spline, Numerical differentiation and integration, Error analysis and convergence; **Probability and Statistics:** Random variables, probability distributions (Discrete and Continuous), Expectation, variance, covariance, Central limit theorem, Law of large numbers, Estimation, confidence intervals, hypothesis testing; **Stochastic Processes & MCMC:** Markov Chains, Bayesian inference, Monte Carlo and Markov Chain Monte Carlo methods, Applications: Sampling, Bayesian Networks, Probabilistic Inference; **Optimization Techniques and Models,** Numerical liner algebra, Ordinary Differential Equations and Applications. **Model verification:** timed automata and hybrid machines**.**

References:

1. G. Strang, Linear Algebra and Learning from Data, (1e), Wellesley, MA: Wellesley-Cambridge Press, 2019.
2. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, (3e), Providence, RI: American Mathematical Society, 2009.
3. S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, (4e), New York, NY: McGraw Hill Education, 2017.

Computer Science & Engineering

Meeting of 36th Board of Studies

Course Code: -	CSE6102	Course Name: -	Advanced Data Structures and Algorithms
Semester: -	1	Branch Name: -	CSE
Course Type: -	Core		
Date:-	25/05/2025		

Pre-requisites (if any):

CSE6102: Advanced Data Structures and Algorithms [3 0 2 4]

Course Contents

Algorithm Foundations: asymptotic notations, recurrence solutions, and amortized complexity; **Parallel Algorithms:** parallel addition, quicksort, selection, search (K-ary), and energy complexity analysis; **Graph Algorithms:** parallel approaches for connected components and maximum independent set; **Advanced Data Structures:** van Emde Boas Trees, Bloom filters, and Count-Min sketch; **Network Flow**: flow networks, augmenting paths, Ford-Fulkerson, Edmonds-Karp, push-relabel, max-flow min-cut, bipartite matching; **Randomized Algorithms**: Las Vegas, Monte Carlo methods, linearity of expectation, Chernoff bounds, min-cut and skip lists; **Online Algorithms:** scheduling, online matching, Steiner tree, and multiplicative weights; **NP-Completeness**: P, NP, NP-Complete, reductions, SAT, Cook's Theorem; **Approximation Algorithms**: TSP (Christofides), Set Cover, PTAS, FPTAS, and LP-based approaches.

~~References:~~

1. Dimitri P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, (2e), Athena Scientific, July 2008.
2. M. Mitzenmacher and E. Upfal, Probability and Compuitng: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, 2017.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, *Introduction to Algorithms*, (3e), MIT Press, 2009.
4. Michael T. Goodrich and Roberto Tamassia, *Algorithm Design and Applications*, (1e), Wiley, 2015.

Computer Science & Engineering

Annexure B3

Meeting of 36th Board of Studies

Course Code: -	CSE6103	Course Name: -	Artificial Intelligence
Semester: -	1	Branch Name: -	CSE
Course Type: -	Core		
Date:-	25/05/2025		

Pre-requisites (if any):

CSE6103: Artificial Intelligence **[3 0 2 4]**

Course Contents

Evolution of AI: symbolic, sub-symbolic, neuro-symbolic; **Intelligent agents:** PEAS, rationality, architectures; **Advanced problem solving and planning**: STRIPS, GraphPlan, HTN, theorem proving; **knowledge representation and reasoning**: propositional and first-order logic, ontologies OWL, RDF, and expert systems; **Probabilistic AI:** feature Bayesian and Markov networks, inference techniques, EM algorithm, and statistical relational learning; **Decision-making and learning:** MDPs, POMDPs, RL methods: Q-learning, DQN, Actor-Critic, with applications in robotics; **Language and vision:** NLP fundamentals, transformers, LLMs (e.g., GPT-4), and computer vision tasks; **cognitive and multi-agent systems**: BDI models, collaboration strategies; **Ethics and responsible AI**: fairness, explainability (LIME, SHAP), governance, and AI alignment.

References:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, (4e), Pearson, 2021
2. Kevin Knight, Elaine Rich, and Shivashankar B. Nair, Artificial Intelligence, (3e), McGraw Hill Publication, 2012.
3. John R. Searle and Matthias Scheutz, The Philosophy of Artificial Intelligence, (1e), Oxford University Press, 2020.

Course Code: -	**CSE6140**	**Course Name: -**	**Applied Cryptography**
Semester: -	**1**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-1**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6140: Applied Cryptography **[4 0 0 4]**

Course Contents

Mathematical Foundations: Modular arithmetic, Number theory, Euler's theorem, Fermat's theorem, Chinese Remainder Theorem, Finite fields; **Symmetric Key Cryptography:** Block ciphers (DES, AES), Modes of operation, Key distribution and management; **Asymmetric Key Cryptography:** RSA, ElGamal encryption, Diffie-Hellman key exchange, Elliptic curve cryptography; **Hash Functions and Message Authentication:** Cryptographic hash functions (MD5, SHA-1, SHA-2, SHA-3), properties of hash functions, message authentication codes (HMAC, CMAC), digital signature algorithms (DSA, ECDSA); **Real-World Cryptographic Deployments:** TLS 1.3 protocol, Signal secure messaging protocol, Bluetooth security features, AWS key management practices; **Lattice-Based Cryptography:** Lattice theory basics, Shortest Vector Problem (SVP), Learning with Errors (LWE), Short Integer Solution (SIS), Module-LWE, Module-SIS problems; **Post-Quantum Cryptography:** Kyber (ML-KEM), Dilithium (ML-DSA), FIPS 203, FIPS 204, performance and implementation considerations.

Reference Books

1. J. Katz and Y. Lindell, Introduction to Modern Cryptography, (3e), Boca Raton, FL: CRC Press, 2020.
2. C. Peikert, A Decade of Lattice Cryptography, Foundations and Trends in Theoretical Computer Science, 2016.
3. N. Ferguson, B. Schneier, and T. Kohno, Cryptography Engineering: Design Principles and Practical Applications, Hoboken, NJ: Wiley, 2010.
4. C. Paar and J. Pelzl, Understanding Cryptography: A Textbook for Students and Practitioners, (1e), Berlin, Germany: Springer, 2010.
5. D. J. Bernstein, J. Buchmann, and E. Dahmen (Eds.), Post-Quantum Cryptography, Berlin, Germany: Springer, 2009.
6. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, (2e), Hoboken, NJ: Wiley, 2015.
7. Alfred J. Menezes, Paul C. van Oorschot, and Scott A. Vanstone, Handbook of Applied Cryptography, (5e), Boca Raton, FL: CRC Press, 2018.

Course Code: -	CSE6141	Course Name: -	Machine Learning
Semester: -	1	Branch Name: -	CSE
Course Type: -	Program Elective-1		
Date:-	25/05/2025		

Pre-requisites (if any):

CSE6141: Machine Learning **[4 0 0 4]**

Course Contents

Mathematical Foundations: optimization, information theory, generalization bounds; **Learning Theory & Regularization**: PAC learning, VC-dimension, Elastic Net, SCAD, model pruning), **Supervised Learning**: kernel methods, Gaussian processes, transfer/meta/few-shot learning, model calibration; **Deep Learning**: CNNs, RNNs, Transformers, AdamW, DropConnect, distributed/mixed-precision training; **Generative Models**: VAEs, GANs, Diffusion Models, FID, IS; **Reinforcement Learning**: PPO, DDPG, Actor-Critic, multi-agent RL, robotics/gaming applications; **Modern Topics**: LLMs, RAG, CLIP, Flamingo, federated learning, XAI, AI fairness; and **Research & Deployment**: reproducibility, ablation studies, ONNX, TensorRT, real-world use cases in healthcare, FinTech, NLP.

References:

1. Tom Mitchell, Machine Learning, (1e), McGraw Hill Publication, 2017.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, (2e), MIT Press, 2012.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, (1e), MIT Press, 2016.

Computer Science & Engineering

Annexure B3

Meeting of 36th Board of Studies

Course Code: -	**CSE6150**	**Course Name: -**	**Cybersecurity Tools & Cyberattacks**
Semester: -	**1**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-2**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6150: Cybersecurity Tools & Cyberattacks **[4 0 0 4]**

Course Contents

Introduction to Cybersecurity and Threat Landscape: Cybersecurity basics and CIA triad; Threat actors and motivations; Types of attacks: DDoS, phishing, ransomware, SQL injection, XSS, malware, APT; Cyber kill chain and attack lifecycle; High-profile cyberattacks and case studies; **Operating System and Network Vulnerabilities:** OS-level vulnerabilities: privilege escalation, file inclusion; Network threats: sniffing, spoofing, MITM attacks; Firewalls, IDS/IPS, honeypots; Vulnerability assessment & exploitation basics; **Cybersecurity Tools and Techniques:** Vulnerability scanning and management; Network monitoring and packet inspection; Log analysis and SIEM basics; Antivirus & malware sandboxing; Security auditing and hardening; **Penetration Testing & Ethical Hacking:** Penetration testing methodology (Recon, Scanning, Gaining Access, Maintaining Access, Reporting); Web application security; Social engineering attacks; Wireless and mobile security; **Mitigation Strategies and Security Best Practices:** Secure system configuration and hardening; Patch management and zero-day response; Security policies and governance; Incident response and digital forensics; Legal and ethical aspects of cybersecurity.

References:

1. W. Stallings, Network Security Essentials: Applications and Standards, (6e), Pearson, 2016.
2. C. Easttom, Computer Security Fundamentals, (4e), Pearson, 2018.
3. J. Erickson, Hacking: The Art of Exploitation, (2e), No Starch Press, 2008.
4. G. Weidman, Penetration Testing: A Hands-On Introduction to Hacking, (2e), No Starch Press, 2014.
5. NIST, Cybersecurity Framework, National Institute of Standards and Technology, 2018. [Online]. Available: https://www.nist.gov/cyberframework
6. CIS, CIS Controls, Center for Internet Security, 2023. [Online]. Available: https://www.cisecurity.org/controls/

Course Code: -	**CSE6151**	**Course Name: -**	**Computer Vision**
Semester: -	**1**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-2**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6151: Computer Vision **[4 0 0 4]**

Course Contents

Introduction: Overview of computer vision and its applications; **Image Formation:** Geometric primitives and transformations; photometric image formation; and the digital camera; **Image Processing:** Point operators; linear filtering; non-linear filtering; Fourier transforms; pyramids and wavelets; and geometric transformations; **Model Fitting and Optimization:** Scattered data interpolation; variational methods and regularization; and Markov random fields; **Deep Learning:** Supervised learning; unsupervised learning; deep neural networks; convolutional networks; and more complex models; **Recognition:** Instance recognition; image classification; object detection; semantic segmentation; video understanding; and vision and language; **Feature Detection and Matching:** Points and patches; edges and contours; contour tracking; lines and vanishing points; and segmentation; **Image Alignment and Stitching:** Pairwise alignment; image stitching; global alignment; and compositing; **Motion Estimation:** Translational alignment; parametric motion; optical flow; and layered motion; **Depth Estimation:** Epipolar geometry; sparse correspondence; dense correspondence; local methods; global optimization; deep neural networks for depth estimation; and multi-view stereo and monocular depth estimation; **Applications and Case Studies:** Autonomous vehicles; medical image analysis; surveillance systems; augmented and virtual reality; and industrial automation.

References:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, (2e), Springer, 2022.
2. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, (2e), Pearson, 2011.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, (2e), Cambridge University Press, 2004.

Course Code: -	**CSE6201**	**Course Name: -**	**Advance Database Management Systems**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Core**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6201: Advance Database Management Systems **[3 0 2 4]**

Course Contents

Advanced Relational Database Design: Functional Dependencies & Normal Forms (BCNF, 4NF, 5NF); Multivalued & Join Dependencies; Relational Decomposition and Lossless Joins; Dependency Preservation; **Query Optimization:** Query Processing and Optimization Techniques; Cost-Based Optimization; Heuristics in Query Optimization; Use of Indexes and Joins Optimization; Query Execution Plans; **Distributed and Parallel Databases:** Distributed DBMS Architecture; Fragmentation, Replication, and Allocation; Distributed Query Processing; Distributed Transactions and Commit Protocols (2PC, 3PC); Parallel Database Architectures and Query Execution; **NoSQL and New Data Models:** Limitations of Relational Model; Key-Value Stores, Document Stores, Column-Family Stores, Graph Databases; CAP Theorem; NoSQL Query Languages; Case Studies: MongoDB / Cassandra / Neo4j; **Big Data and Cloud Databases:** Big Data Characteristics; Hadoop Ecosystem Overview; HDFS, MapReduce; Cloud Data Management; Database-as-a-Service (DBaaS): Amazon RDS / Google Cloud Spanner; **Advanced Topics and Research Trends:** Data Warehousing and OLAP; Temporal and Spatial Databases; Data Streams and Real-Time Analytics; Semantic Web and RDF Stores; Introduction to GraphQL and NewSQL; Privacy, Security, and Ethics in Data Management.

References:

1. A. Silberschatz, H. F. Korth, and S. Sudarshan, Database System Concepts, (7e), McGraw Hill Publication, 2019.
2. M. T. Özsu and P. Valduriez, Principles of Distributed Database Systems, (3e), Boston, MA: Springer, 2015.
3. P. J. Sadalage and M. Fowler, NoSQL Distilled, (1e), Boston, MA: Addison-Wesley, 2012.

Course Code: -	**CSE6202**	**Course Name: -**	**Advance Programming Paradigm**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Core**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6202: Advance Programming Paradigm **[3 0 2 4]**

Course Contents

Hash tables: Consistent hashing; Locality-sensitive hashing; Bloom filters; Cuckoo hashing; **Data structures for combinatorial optimization:** Fibonacci heaps; dynamic graph structures; **Search trees:** Skip lists; **Self-adjusting data structures:** Splay Trees; **Tries and suffix trees; Geometric data structures;** Implementation of HITS and Page Rank algorithms; Implement the online advertisement problem as a bipartite matching problem; **Message Passing Interface (MPI):** Basics of MPI; Communication between MPI processes; Basics of OpenMP API; Sharing of work among threads using loop constructs in OpenMP.

Reference Books:

1. T. Roughgarden, CS261: A Second Course in Algorithms, Stanford University, 2016; and Randomized Algorithms: COMS 4995, Columbia University, 2019.
2. T. Roughgarden, CS168: The Modern Algorithmic Toolbox, Stanford University, Spring 2017.
3. R. Motwani, CS361A: Advanced Data Structures and Algorithms, Stanford University, Autumn Quarter 2005–06.
4. Stanford University, CS166: Data Structures, 2016–2021. Available: https://web.stanford.edu/class/cs166/.

Course Code: -	**CSE6203**	**Course Name: -**	**Advance Computer Networks**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Core**		
Date:-	**25/05/2025**		

Pre-requisites (if any): Computer Networks components, models, protocols and services.

CSE6203: Advance Computer Networks **[3 0 2 4]**

Course Contents

Introduction: Error control, flow control and traffic management system in computer networks; **Flow Control:** classification; open-loop flow control; closed loop flow control; and hybrid flow control; **Traffic Management:** Traffic Models; Traffic Classes; Time Scales of Traffic Management; Scheduling; Renegotiation; Signalling; Admission Control; Peak-Load Pricing and Capacity Planning; (Differentiated Service; Quality of Service; Traffic Polishing; Traffic Shaping); **Mathematics for Computer network: Stochastic Processes and Queueing Theory:** Stochastic Processes; Continuous-time Markov Chains; Birth-death processes; The M/M/1 queue and its variations; M/D/1 : deterministic service times; G/G/1 and network of queues; **Network Softwarization:** Software Defined Networking (SDN) - Deep Dive (Northbound and Southbound interface); Deep Dive (Network topologies; Container Network Interfaces); Working with Mininet; **Data Center Networking:** Network Function Virtualization (NFV) - Architecture and Concepts; Programmable Networks - Introduction to P4; SmartNICS and P4 switches; Content Distribution on the Internet; Architectures for Information Centric Networking.

References:

1. S. Keshav, An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network, (1e), Boston, MA: Addison-Wesley, 1997.
2. S. Keshav, Mathematical Foundations of Computer Networking, (1e), Boston, MA: Addison-Wesley, 2012.
3. H. J. Chao and B. Liu, High Performance Switches and Routers, (1e), Hoboken, NJ: Wiley-IEEE Press, 2007.
4. G. M. de Brito, P. B. Velloso, and I. M. Moraes, Information-Centric Networks: A New Paradigm for the Internet, (1e), Hoboken, NJ: Wiley-ISTE, 2013.
5. B. Wissingh, C. Wood, A. Afanasyev, L. Zhang, D. Oran, and C. Tschudin, Information-Centric Networking (ICN): Content Centric Networking (CCNx) and Named Data Networking (NDN) Terminology, RFC 8793, June 2020.
6. L. Peterson, B. Davie, T. Vachuska, M. Cascone, and A. O'Connor, Software-Defined Networks: A Systems Approach, (Online Edition), 2020.
7. G. Lee, Cloud Networking: Understanding Cloud-Based Data Center Networks, (1e), Waltham, MA: Morgan Kaufmann, 2014.

Course Code: -	**CSE6240**	**Course Name: -**	**Digital Forensics**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-3**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6240: Digital Forensics **[4 0 0 4]**

Course Contents

Introduction to Digital Forensics: Cybercrimes; Overview of hardware and operating systems; types of digital evidence; Logical structure of storage media/devices; Branches of Digital Forensics; Phases of Digital forensics; Seizure; Chain of custody; Various File Systems; Type of Acquisition live vs standalone machine; memory volatility and precautions; Hidden/deleted Data recovery HPA, DCO; Computer forensics tools; **Network Forensics:** Cyber-attacks on network; network-based digital evidence; Acquisition; live acquisitions; Traffic Analysis; wireless network forensics; Event log analysis; Intrusion detection; Reconstructing web browsing; email investigation; Network forensics tools; **Mobile Forensics:** Different OS and Memory in Mobile phones; collecting evidence; preservation methods; interpretation of digital evidence on mobile networks; Mobile Forensics Tools; **IoT Forensics:** Analyzing evidence from IoT devices and smart systems; Forensic Toolkit for IoT; Cellebrite IoT Module; IoT-Analyzer; **Cyber Laws and Ethics:** Indian IT Act; Intellectual property right; Criminal Justice system for forensics; Audit/investigative; Investigative procedures/standards for extraction, preservation, and deposition of legal evidence in a court of law; challenges in court of law.

References:

1. B. Nelson, A. Phillips, and C. Steuart, Guide to Computer Forensics and Investigations, (6e), Boston, MA: Cengage Learning, 2018.
2. S. H. Davidoff and J. Ham, Network Forensics: Tracking Hackers Through Cyberspace, (1e), Indianapolis, IN: Prentice Hall, 2012.
3. R. Montasari, H. Jahankhani, R. Hill, and S. Parkinson, Digital Forensic Investigation of Internet of Things (IoT) Devices, (1e), Cham, Switzerland: Springer, 2020.
4. K. Barmpatsalou, T. Cruz, E. Monteiro, and P. Simoes, Mobile Device Forensics: A Practitioner's Guide to iOS and Android Investigations, (1e), Hoboken, NJ: Wiley, 2022.
5. P. Duggal, Cyber Law: An Exhaustive Section-Wise Commentary on the Information Technology Act Along With Rules, Regulations, Policies, Notifications, etc., (1e), Nagpur, India: Wadhwa Book Company, 2023.

Course Code: -	**CSE6241**	**Course Name: -**	**Reinforcement Learning**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-3**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6241: Reinforcement Learning **[4 0 0 4]**

Course Contents

Introduction: Introduction to Machine Learning and its various types; Motivation and Introduction to Reinforcement Learning; Multi arm Bandits; Markov Decision Process; Value functions; **Dynamic programming:** Policy evaluation and improvement; Value iteration and Policy iteration algorithms; **Tabular RL & Model-Free Prediction & Control:** Dynamic Programming (DP) Methods: Policy Evaluation and Improvement; Value Iteration and Policy Iteration Algorithms; Monte Carlo (MC) Methods: Prediction and Estimation of Action Values; Temporal Difference (TD) Learning: TD(0), SARSA, Q-Learning; Off-Policy Learning: Importance Sampling; Convergence Guarantees; **Function Approximation and Deep Reinforcement Learning:** Value Function Approximation: Linear and Non-linear Methods; Deep Q-Networks (DQN) and Variants; Policy Gradient Methods: REINFORCE, Actor-Critic, PPO, DDPG; Model-Based vs. Model-Free RL; **Advanced Reinforcement Learning:** Imitation Learning: Behavioral Cloning, Inverse RL, Generative Adversarial Imitation Learning (GAIL); Meta-Learning in RL: Fast Adaptation, Model-Agnostic Meta-Learning (MAML); Multi-Agent RL (MARL): Cooperative/Competitive Settings; Partially Observable Environments (Dec-POMDPs); Batch and Offline RL: Challenges and Solutions; **Applications and Emerging Trends Real-World Applications:** Game Playing; Robotics; Autonomous Systems; Neural Architecture Search (NAS) using RL; Ethical and Safety Considerations.

References:

1. R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction, (2e), Cambridge, MA: MIT Press, 2018.
2. C. Szepesvári, Algorithms for Reinforcement Learning, (1e), San Rafael, CA: Morgan & Claypool, 2010.
3. Z. Xiao, Reinforcement Learning: Theory and Python Implementation, (1e), Singapore: Springer, 2024.
4. S. E. Li, Reinforcement Learning for Sequential Decision and Optimal Control, (1e), Singapore: Springer, 2024.

Course Code: -	**CSE6250**	**Course Name: -**	**Blockchain Technology**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-4**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6250: Blockchain Technology **[4 0 0 4]**

Course Contents

Introduction to Blockchain Technology: Overview of Blockchain; History and Evolution; Features of Blockchain; Types of Blockchain (Public, Private, Consortium); **Blockchain Architecture and Components:** Blocks; Transactions; Hash Functions; Merkle Trees; Distributed Ledger Technology (DLT); P2P Networks; **Consensus Mechanisms:** Proof of Work (PoW); Proof of Stake (PoS); Delegated PoS; Practical Byzantine Fault Tolerance (PBFT); Comparison of Mechanisms; **Cryptography in Blockchain:** Hashing; Digital Signatures; Public Key Infrastructure (PKI); Wallets and Addresses; Security and Privacy; **Smart Contracts and Ethereum:** Introduction to Ethereum; Solidity Programming Basics; Writing and Deploying Smart Contracts; Gas and Transactions; Tools like Remix, Ganache, MetaMask; **Blockchain Applications:** Use Cases in Banking; Healthcare; Supply Chain; Government; Voting Systems; NFTs and Metaverse Basics; **Challenges and Future Trends:** Scalability; Interoperability; Energy Consumption; Legal and Regulatory Issues; Blockchain beyond Cryptocurrency.

References:

1. Melanie M. Swan, Blockchain: Blueprint for a New Economy, (1e), Sebastopol, CA: O'Reilly Media, 2015.
2. A. M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, (2e), Sebastopol, CA: O'Reilly Media, 2017.
3. I. Bashir, Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained, (3e), Birmingham, UK: Packt Publishing, 2020.
4. R. Wattenhofer, The Science of the Blockchain, (1e), Zurich, Switzerland: Distributed Computing Group, ETH Zurich, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, and S. Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, (1e), Princeton, NJ: Princeton University Press, 2016.

Course Code: -	CSE6251	Course Name: -	Generative AI
Semester: -	2	Branch Name: -	CSE
Course Type: -	Program Elective-4		
Date:-	25/05/2025		

Pre-requisites (if any):

CSE6251: Generative AI **[4 0 0 4]**

Course Contents

Introduction to Generative AI: Overview, history, and foundational concepts; **Generative Adversarial Networks (GANs):** architectures, training strategies, conditional GANs; **Variational Autoencoders (VAEs):** theory, implementation, and variations; Diffusion Models and Flow-based Generative Models; **Applications in Natural Language Processing:** transformer-based models, GPT series; **Image Generation:** StyleGAN, DALL-E; Audio and Video Generation; **Evaluation Metrics for generative models:** inception score, FID, precision-recall curves; **Ethical considerations and societal impact of generative AI, responsible AI practices**.

References:

1. I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, (1e), Cambridge, MA: MIT Press, 2016.
2. D. Foster, Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, (2e), Sebastopol, CA: O'Reilly Media, 2022.
3. F. Chollet, Deep Learning with Python, (2e), Shelter Island, NY: Manning Publications, 2021.
4. L. Weng, Generative Models, OpenAI Technical Report and Blogs, 2018. Available: https://lilianweng.github.io/lil-log/
5. R. Valle, Hands-On Generative Adversarial Networks with Keras: Your Guide to Implementing Next-Generation Generative Adversarial Networks, (1e), Birmingham, UK: Packt Publishing, 2019.

Course Code: -	**CSE6261**	**Course Name: -**	**Quantum Computing**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-5**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6261: Quantum Computing **[4 0 0 4]**

Course Contents

Quantum Theory Foundations: qubits, gates, measurements, Hilbert spaces, unitary operators, entanglement, decoherence; **Measurement frameworks**: projective measurement, POVMs, non-classical phenomena like Bell inequalities and the CHSH game; **Quantum Algorithms**: circuit models, teleportation, superdense coding, Deutsch-Jozsa, Grover's, Simon's, Shor's algorithms, VQE, QAOA, hybrid quantum-classical methods using Qiskit, PennyLane; **Quantum Error Correction:** noise models, Shor and Steane codes, surface codes, fault tolerance, logical qubit construction; **Quantum Cryptography**: BB84, E91, QKD networks, device-independent protocols, post-quantum cryptography; **Hardware section:** superconducting, ion-trap, photonic, spin-based, and topological qubits, coherence, control, scaling challenges; **Quantum Metrology:** precision limits, enhanced sensors, applications in imaging and navigation; **Quantum Networks:** entanglement distribution, repeaters, quantum internet architecture, national initiatives; **Quantum Software and Simulation:** Language: Qiskit, Cirq, Q#, simulators: QuTiP, QuEST, and quantum system simulations in science.

References:

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, (10e), Cambridge, UK: Cambridge University Press, 2010.
2. G. Benenti, G. Casati, D. Rossini, and G. Strini, Principles of Quantum Computation and Information: A Comprehensive Textbook, (1e), Singapore: World Scientific, 2019.
3. C. C. Gerry and P. L. Knight, Introductory Quantum Optics, (2e), Cambridge, UK: Cambridge University Press, 2023.
4. D. Bouwmeester, A. Ekert, and A. Zeilinger (Eds.), The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation, (1e), Berlin, Germany: Springer, 2000.
5. H. M. Wiseman and G. J. Milburn, Quantum Measurement and Control, (1e), Cambridge, UK: Cambridge University Press, 2010.

Course Code: -	**CSE6262**	**Course Name: -**	**Natural Language Processing**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-5**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6262: Natural Language Processing **[4 0 0 4]**

Course Contents

Introduction: Ambiguity and uncertainty in language; phases in natural language processing; **Linguistic resources:**Introduction to corpus; WordNet; IndoWordNet; VerbNet; **Text preprocessing:** Tokenization; Normalization; Edit distance; Advanced Edit distance; **Part of Speech tagging:** Stochastic POS tagging; handling of unknown words; named entity recognition; multi word expression; Word sense Disambiguation; Hidden Markov Model; Viterbi algorithm; **Parsing:** Top down; Bottom up; CYK; CFG; PCFG; **Text representation and Language model:** Bag of Word; Tf-Idf; Ngram; evaluation of language model; smoothening; **DeepNLP:** Embedding; One hot representation; Distributed representation and its evaluation; Recurrent neural network; Long Short-Term Memory (LSTM); Convolutional neural network; Self Attention mechanism; Introduction to Transformer architecture; **Discourse:** Reference resolution; constraints on co-reference; algorithm for pronoun resolution; text coherence; discourse structure; **Topic Modeling:**Latent Dirichlet Allocation (LDA); Non-negative Matrix Factorization (NMF); Visualizing topics and clusters; **Application of NLP:** Text summarization; Sentiment Analysis; Aspect based sentiment analysis; Question Answering system.

References:

1. D. Jurafsky, J. H. Martin, *Speech and Language Processing*, (3e), Pearson, 2025.
2. L. Tunstall, L. v. Werra, Thomas Wolf, *Natural Language Processing with Transformers*, (1e), O'Reilly Media, 2022.
3. D. Rothman, *Transformers for Natural Language Processing*, (2e), Packt Publishing, 2022.

Computer Science & Engineering

Annexure B3

Meeting of 36th Board of Studies

Course Code: -	CSE6263	Course Name: -	Social Networks Analysis
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-5**		
Date:-	**25/05/2025**		

Pre-requisites (if any): Foundational knowledge of graph theory, familiarity with data-collection techniques, and capability to interpret network structures and relationships.

CSE6263: Social Networks Analysis **[4 0 0 4]**

Course Contents

Introduction: Key concepts, applications, and measures in network analysis; Nodes, Edges, and Network measures; Describing Nodes and Edges; Describing Networks; Layouts; **Properties of Real-World Networks:** Random graphs; small worlds problem; **Network Measures & Structural Roles - Centrality:** Degree Centrality; Eigenvector Centrality; Katz Centrality; PageRank Centrality; Closeness Centrality; Group Centrality; **Transitivity and Reciprocity; Balance and Status; Similarity:** Structural Equivalence; Regular Equivalence; **Community Discovery & Dynamics - Member-based:** Girvan–Newman (edge betweenness); Louvain (greedy modularity); Label Propagation; **Group-based:** Stochastic Block Models; overview of inference via EM; **Temporal evolution:** snapshot vs incremental clustering; concept drift; illustrative; **Evaluation:** modularity; conductance; coverage (without ground truth); NMI; ARI (with ground truth); **Link prediction:** similarity indices (CN, AA, Jaccard); path-based (Katz); supervised binary classifiers; discussion on cold-start and sparsity; **Graph Representation Learning & Network Applications - Shallow embeddings:** DeepWalk; Node2Vec; LINE—skip-gram objective and hyper-parameter effects; **Knowledge graphs & meta-paths:** metapath2vec; path-based attention; **Graph neural networks:** Spectral vs spatial GCNs; GraphSAGE; attention-based variants; **Influence & outbreaks:** independent-cascade and linear-threshold models.

References:

1. D. Easley and J. Kleinberg, Networks, Crowds and Markets, Cambridge, 2010.
2. M. Newman, Networks: An Introduction, Oxford, 2010.
3. C. C. Aggarwal, Social Network Data Analytics, Springer, 2011.
4. T. Chakraborty, Social Network Analysis, Wiley, 2021.
5. S. P. Borgatti, M. G. Everett, and J. C. Johnson, Analyzing Social Networks, (2e), SAGE Publications Ltd, 2018.
6. J. Scott, Social Network Analysis, (3e), SAGE Publications Limited, 2013.
7. D. Jurafsky and J. H. Martin, Speech and Language Processing, (3e), Pearson, 2025.

Course Code: -	**CSE6264**	**Course Name: -**	**Recommender Systems**
Semester: -	**2**	**Branch Name: -**	**CSE**
Course Type: -	**Program Elective-5**		
Date:-	**25/05/2025**		

Pre-requisites (if any):

CSE6264: Recommender Systems **[4 0 0 4]**

Course Contents

Introduction to Recommender Systems: What is a recommendation engine?; Need for recommender systems; Framework of recommendation systems; Personalization strategies; Privacy concerns; Functions and techniques in recommender systems; Role of Human-Computer Interaction; Dataset challenges: the cold-start problem; **Collaborative Filtering-based Techniques:** understanding ratings and rating data; User-based nearest neighbour recommendation; Item-based nearest-neighbour recommendation; Model-based and preprocessing-based collaborative filtering approaches; Comparison of user-based and item-based recommendation techniques; Concept drift and data drift in collaborative filtering; **Content-based Recommender Systems:** Architecture of content-based recommenders; Content representation and content similarity: item profiles, feature extraction, use of tags; Learning user profiles: profile representation and filtering; Similarity-based retrieval methods; Classification algorithms for content recommendation; Knowledge-based recommenders: knowledge representation and reasoning; Constraint-based and case-based recommenders; **Constraint-based Approaches:** Constraint-based recommenders: recommendation knowledge base development, user guidance, recommendation calculation; **Evaluation of Recommender Systems:** Evaluation paradigms: offline evaluation design and goals; Case study: Netflix Prize dataset; Data partitioning techniques: hold-out and cross-validation; Accuracy metrics: RMSE vs. MAE; Impact of the long tail; Ranking evaluation: correlation-based metrics, utility-based metrics, ROC-based evaluation.

References:

1. M. D. Ekstrand, J. T. Riedl, and J. A. Konstan, Collaborative Filtering Recommender Systems, (1e), Now Publishers, 2011.
2. J. Leskovec, A. Rajaraman, and J. Ullman, Mining of Massive Datasets, (2e), Cambridge University Press, 2012.
3. P. Pavan Kumar, S. Vairachilai, and Sirisha Potluri, Recommender Systems: Algorithms and Applications, (1e), CRC Press, 2021.

Computer Science & Engineering

Annexure B3

Meeting of 36th Board of Studies

Course Code: -	CSE6265	Course Name: -	Cloud Infrastructure and Virtualization
Semester: -	2	Branch Name: -	CSE
Course Type: -	Program Elective-5		
Date:-	25/05/2025		

Pre-requisites (if any):

CSE6265: Cloud Infrastructure and Virtualization **[4 0 0 4]**

Course Contents

Cloud Architecture: layered design, NIST reference model, cloud deployment models (public, private, hybrid); **Service models:** IaaS, PaaS, SaaS, cloud storage concepts, advantages, cloud computing reference model; **Historical developments:** distributed systems, virtualization, Web 2.0, utility computing. **Building cloud environments:** Infrastructure development, AWS, Google App Engine, Microsoft Azure, Hadoop, Salesforce; **AWS tools**: EC2, ECS, Code Commit, Build, Deploy, Pipeline, CloudWatch, Auto Scaling, Control Tower; **Virtualization** virtualization characteristics, taxonomy, hardware virtualization, desktop virtualization; **Virtual machines**: process and system VMs, memory and instruction emulation, dynamic binary optimization, resource virtualization; **Case study:** Intel VT-x, Pros and cons of virtualization technologies like Xen, VMware, and Hyper-V.

References:

1. R. Buyya, J. Broberg, and A. Goscinski, Cloud Computing Principles and Paradigms, (1e), Wiley Publishers, 2013.
2. B. Sosinsky, Cloud Computing Bible, (1e), Wiley, 2011.
4. M. Miller, Cloud Computing: Web-based Applications that change the way you work and collaborate online, (1e), Pearson, 2008.
5. D. S. Linthicum, Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, (1e), Addison Wesley Information Technology Series, 2010.
6. T. Velte, A. T. Velte, and R. Elsenpeter, Cloud Computing: A Practical Approach, (1e), McGraw Hill, 2017.