Department of Computer Science and Engineering
UNIVERSITY OF KALYANI, KALYANI 741235
WEST BENGAL

SYLLABUS

FOR

MASTER OF TECHNOLOGY (M.Tech.) in COMPUTER SCIENCE & ENGINEERING
(Two-Year Programme)

As per
AICTE MODEL CURRICULUM
(Effective from the Session: 2021-22)

Paper Code Convention: CSE – XYZ
[X = 1/2/3/4 (semester), Y = 0/1/2/3 (theory/practical/project/viva), Z (paper id)]

Paper Code	Paper Name	Type	Credit	Weekly hours (L+T+P)	Marks Theory - (Exam+Internal Assessment)
Semester - I					
CSE–101	Advanced Operating Systems	Theory	4	3+1+0	100 (80+20)
CSE–102	Advanced Database Systems	Theory	4	3+1+0	100 (80+20)
CSE–103	Advanced Mathematics	Theory	4	3+1+0	100 (80+20)
CSE–104	Advanced Computer Architecture	Theory	4	3+1+0	100 (80+20)
CSE–105	Advanced Design and Analysis of Algorithms	Theory	4	3+1+0	100 (80+20)
CSE–111	Advanced Computing Lab-I	Practical	4	0+0+6	100
TOTAL			24	26	600
Semester - II					
CSE–201	Soft Computing	Theory	4	3+1+0	100 (80+20)
CSE–202	Mobile & Wireless Computing	Theory	4	3+1+0	100 (80+20)
CSE–203	Elective I	Theory	4	3+1+0	100 (80+20)
CSE–204	Elective II	Theory	4	3+1+0	100 (80+20)
CSE–205	Elective III	Theory	4	3+1+0	100 (80+20)
CSE–211	Advanced Computing and Communication Lab	Practical	4	0+0+6	100
CSE–221	Review Work & Seminar	-	6	-	100
TOTAL			30	26	700
Semester - III					
CSE–301	Elective IV	Theory	4	3+1+0	100 (80+20)
CSE–302	Elective V	Theory	4	3+1+0	100 (80+20)
CSE–311	Advanced Computing Lab-II	Practical	4	0+0+6	100
CSE–321	Thesis I	Project	12	0+0+20	300
TOTAL			24	34	600
Semester - IV					
CSE – 421	Thesis II	Project	18	0+0+24	400
CSE – 431	Grand Viva	Viva	6	-	200
TOTAL			24	24	600
Overall Total			102	110	2500

Elective Papers

1. IoT and Sensor Networks
2. Machine Learning
3. Theory of Computing
4. Pattern Recognition
5. Artificial Intelligence
6. Advanced Software Engineering
7. Advanced Network Security & TCP/IP Programming
8. Blockchain Technology
9. Real Time & Embedded Systems
10. Management Information Systems
11. Optical Networks
12. Cloud Computing
13. Network Administration
14. High Performance Computing Architecture
15. Web Mining and Internet Technology
16. Authentication & Steganography
17. Data Warehousing and Data Mining
18. Digital Image Processing

* New elective papers may included/offered as per the need of the industry and modern technologies as and when required with the approval of the PG-BoS of Dept. of Computer Science & Engineering.

Semester-I

CSE 101	Advance Operating Systems	L-T-P : 3-1-0	Credit: 4	40L

Distributed Systems : Hardware and Software concepts – Design issues;
Communication in Distributed systems : Layered protocols - ATM networks - Client Server model – Remote Procedure Calls.
Synchronization : Clock synchronization – Mutual exclusion – Election algorithms, - Atomic transactions – Deadlocks; Processes : Threads – System models – processor allocation – Scheduling – Fault tolerance – Real time distributed systems.

Shared memory : Consistency models – Page based distributed shared memory – Shared variables – Object based distributed shared memory; Distributed File Systems : Design and Implementation.

Case Study: Introduction to Amoeba – Object and Capabilities – memory management – Communication – Amoeba Servers.

Text Books:
1. Mukesh Singhal, Niranjan G Shivratri , " Advanced Concepts in Operating Systems", McGraw Hill International, 1994.
2. Silbersehatz A. and Peterson J. L., "Operating System Concepts", Wiley.

Reference Books:
1. Andrew S Tanenbaum , " Distributed Operating Systems " , Pearson Education India, 2001.
2. Pradeep K Sinha , " Distributed Operating Systems Concepts and Design ", PHI, 2002.

CSE 102	Advance Database Systems	L-T-P : 3-1-0	Credit: 4	40L

Relational Database Management Issues - Transaction Processing, Concurrency, Recovery, Security and
Integrity.
Distributed Databases - Storage structures for distributed data, data fragmentation, Transparency of distributed architecture, Distributed query processing, Transaction management in distributed environment,
Recovery and Concurrency control, Locking protocols, Deadlock handling, Dynamic modeling of distributed
databases, Client - Server Databases.
Performance Tuning, Advanced Transaction Processing.
Object-oriented Databases - Objects and Types, Specifying the behavior of objects, Implementing Relationships, Inheritance.
Sample Systems.

New Database Applications.
Multimedia Database - Multimedia and Object Oriented Databases, Basic features of Multimedia data management, Data Compression Techniques, Integrating conventional DBMSs with IR and Hierarchical Storage Systems, Graph Oriented Data Model, Management of Hypertext Data, Client Server Architectures
for Multimedia Databases

Text Books:
1.H. F. Korth & A. Silverschatz: Database Systems Concepts, McGraw Hill.
2.Bindu R. Rao: Object Oriented Databases, McGraw Hill, 1994.
3.Gray, Kulkarni, and Paton: Object Oriented Databases, Prentice Hall International, 1992.
4.Khoshafian: Object Oriented Databases, John Wiley & Sons, 1993.

Reference Books:
1. S. Khoshafian & A. B. Baker, Multimedia and Imaging Databases, Morgan Kaufmann Publishers, 1996.
2. Kemper & Moerkoette: Object-Oriented Database Management, PH, 1994.
3. Alex Berson: Client/Server Architecture, McGraw Hill.

CSE 103	Advance Mathematics	L-T-P : 3-1-0	Credit: 4	40L

Combinatorics: Multinominal theorem, principle of inclusion; Recurrence relations – classification, summation method, extension to asymptotic solutions for subsequences; Linear homogeneous relations, characteristic root method, general solution for distinct and repeated roots, non-homogeneous relations and examples, generating functions and their application to linear homogeneous recurrence relations, non-linear recurrence relations, exponential generating functions, brief introduction to Polya theory of counting.

Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments, trees; Minimum spanning tree, rooted trees and binary trees, planar graphs, Euler's formula, statement of Kuratowskey's theorem, dual of planer graph, independence number and clique number, chromatic number, statement of Four-color theorem, dominating sets and covering sets.

Logic: Propositional Calculus- propositions and consecutives, syntax; Semantics- truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of consecutives; Equivalence and normal forms; Compactness and resolution; Formal reducibility – natural deducation system and axiom system; Soundness and completeness.

Introduction to Predicate Calculus: Syntax of first order language; Semantics- structures and interpretation; Formal deductibility, First Order theory, models of a first order theory (definition only), validity, soundness, completeness, compactness (statement only), outline of resolution principle.

Text Books:
1. J.L. Mott, A. Kandel and T.P. Baker: Discrete Mathematics for Computer Scientists, Reston, Virginia, 1983.
2. D.F. Stanat and D.E. McAllister: Discrete Mathematics in Computer Science, Prentice Hall, Englewood Cliffs, 1977.
3. R.A. Brualdi: Introductory Combinatorics, North-Holland, New York, 1977.
4. Reingold et al.: Combinatorial algorithms: theory and Practice, Prentice Hall, Englewood Cliffs, 1977.
5. J.A. Bondy and U.S.R. Murthy: Graph Theory with Applications, Macmillan Press, London, 1976.
6. N. Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, Englewood Cliffs, 1974.
7. E. Mendelsohn: Introduction to Mathematical Logic, 2nd Ed. Van-Nostrand, London, 1979.
8. L. Zhongwan: mathematical Logic for Computer Science, World Scientific, Singapore, 1989.
9. F.S. Roberts: Applied Combinatorics, Prentice Hall, Englewood Cliffs, 1984.

Reference Books:
1. J.P Tremblay and R. Manohar: Discrete Mathematical Structures with Applications to Computers.
2. J.L. Gersting: Mathematical Strcutures for Computer Sciences.
3. S. Lipschutz: Finite Mathematics.
4. S. Wiitala: Discrete Mathematics – A Unified Approach.
5. C. L. Liu : Elements of Discrete Mathematics.
6. K . D. Joshi : Foundation of Discrete Mathematics.
7. S. Sahani : Concept of Discrete Mathematics.
8. L. S. Levy : Discrete Structure in computer Science.
9. J. H. Varlist and R. M. Wilson: A course in Combinatorics.

CSE 104	Advanced Computer Architecture	L-T-P : 3-1-0	Credit: 4	40L

Fundamentals of Computer design- Technology trends- cost- measuring and reporting performance quantitative principles of computer design.
Memory hierarchy design- cache performance- reducing cache misses penalty and miss rate – virtual memory- protection and examples of VM.
Instruction set principles and examples- classifying instruction set- memory addressing- type and size of operands- addressing modes for signal processing-operations in the instruction set- instructions for control flow- encoding an instruction set.-the role of compiler.
Instruction level parallelism (ILP)- over coming data hazards- reducing branch costs –high performance instruction delivery- hardware based speculation- limitation of ILP
ILP software approach- compiler techniques- static branch protection – VLIW approach – H.W support for more ILP at compile time- H.W versus S.W Solutions
Multiprocessors and thread level parallelism- symmetric shared memory architectures- distributed shared memory- Synchronization- multi threading.

Text Book:
1. Computer Architecture A quantitative approach 3rd edition John L. Hennessy & David A. Patterson Morgan Kufmann (An Imprint of Elsevier)

Reference Books:
1. Advanced Computer Architectures, Dezso Sima, Terence Fountain, Peter Kacsuk, Pearson.
2. “Computer Architecture and parallel Processing” Kai Hwang and A.Briggs International Edition McGraw-Hill.

CSE 105	Advanced Design and Analysis of Algorithms	L-T-P:3-1-0	Credit: 4	40L

Quick Review of basic concepts - complexity measures, worst-case, average case and amortized complexity
functions, model of computation.

Algorithm Design Paradigm - Divide and Conquer, Recursion, Greedy method, Dynamic programming. Role of Data Structures.

Sorting and Selection Problems: Order Statistics, sorting methods, lower bounds.

Searching and Selection Problems: Order Statistics, sorting methods, lower bounds.

Searching and Set manipulation: Searching in Static table - path lengths in Binary trees and applications,
optimality of Binary search in worst case and average case, construction of weighted Binary Search tree.
Searching in dynamic table - randomly grown binary search trees, AVL trees, (a, b) trees; Union-find problem -tree representation of set, weighted union and path compression, analysis and application.
Hashing:
chaining, open addressing, universal hashing function.

Graph algorithms: Review of topological sort, connected and biconnected components, shortest paths, minimum spanning trees. Maximum matching, maximum-flow (Ford-Fulkerson).

Arithmetic and Algebraic problems: Integer multiplication, GCD, Polynomial evaluation, Matrix Multiplication, Lower Bounds. Introductory Stringology. Some geometric algorithms.

NP-completeness: Determinism and non-determinism, P, NP, NP-complete, Cook's theorem, Some NP complete problems, Approximation algorithms. Notion of Randomization and Parallelism in algorithms.

Text Books:
1. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, MIT Press, 1990.
2. U. Manber: Introduction to Algorithms, Addison-Wesley, 1989.

Reference Books:
1. G. Brassard and P. Bartley: Algorithmics: Theory and Practice, Prentice Hall International 1996.
2. A. V. Aho, J. E. Hopcroft and J. D. Ullman: Design and Analysis of Algorithms, Addison-Wesley, 1974.

CSE 105	Advanced Computing Lab - I	L-T-P : 0-0-6	Credit: 4	FM: 60P

Semester-II

CSE 201	Soft Computing	L-T-P : 3-1-0	Credit: 4	40L

Fuzzy Logic and Approximate Reasoning:
Conventional and fuzzy sets: Basic concepts of fuzzy logic
Fuzzy expressions: Basic principles of fuzzy logic and fuzzy inference rules, fuzzy relations, fuzzy operators, realization of fuzzy systems using fuzzy relations
Application of fuzzy logic in vision, pattern recognition, robotics and linguistics. Approximate reasoning in Experts Systems, Fuzzy sets in approximate reasoning, Fuzzy propositions in approximate reasoning. Transition Modifier rules, Basic principles of approximate reasoning and rules of inference.
Genetic Algorithms (GAs): Introduction to GAs, Binary encodings of candidate solutions, Schema Theorem and Building Block Hypothesis, Genetic operators – crossover and mutation, parameters for GAs, Reproduction mechanism for producing Offspring, Darwinian Principle in evaluating objective function. Convergence Analysis: Simple GA schemes, Stochastic models: GA approaches to optimization problems.
Basic Concepts and Principles of Neural Networks (NNs) and Learning Systems.
Learning with GAs and Artificial NNs (ANNs); Composite use of Fuzzy Logic, ANNs and GAs.
Neurocomputing: Models of Neurocomputing: (a) Perceptron Training, (b) Back propagation learning, (c) Hopfield nets, (d) Adaptive resonance theory I & II, (e) Self-organizing feature map, (f) ADALINE. Applications in pattern classification and image understanding.
Chaos Theory, Fusion of Neuro, Fuzzy, GA & Chaos theory & Applications to simple problems.

Text Books:
1. David E. Goldberg: Genetic Algorithms in Search, Optimization and Machine Learning, Addision Wesley, MA, 1989.
2. S. Haykin: Neural Networks - A Comprehensive Foundation, Macmillan College Publishing Company, New York, 1994.
3.H. J. Zimmermann: Fuzzy set theory and its application, 2nd revised edition, Allied Publishers Ltd.
4. G. J. Klir, B. Yuan: Fuzzy sets and Fuzzy logic: Theory and Applications, PHI, 1995.
5.R. L. Devaney: An Introduction to Chaotic Dynamical Systems, 2nd Ed. Addision Wesley, 1989.
6. An Introduction to Genetic Algorithms – M. Mitchell.
7. Genetic Algorithms – K. F. Man, K. S. Tang and S. Kwong.
8. Genetic Algorithms + Data Structures = Evolution Programs – Z. Michalewicz.
9. Adaptation in Natural and Artificial Systems - J. H. Holland.
10. Genetic Algorithms : for VLSI Design, Layout & Test Automation – P. Mazumder and E. M Rudnick.

Reference Books:
1. Neuro- Fuzzy and Soft Computing : A Computational Approach to Learning and Machine Intelligence - J. S. R. Jang C. T. Sun and E. Mizutani.
2. Theory and Practice of Uncertain Programming – B. Liu.
3. Fuzzy Logic for the Applications to Complex Systems – W. Chiang and J. Lee.
4. Fuzzy Logic with Engineering Applications – T. J. Ross.
5. Neural Network and Fuzzy Systems : A Dynamical Systems Approach to Machine Intelligence – B. Kosko.

CSE 202	Mobile & Wireless Computing	L-T-P : 3-1-0	Credit: 4	40L

Wireless Transmission-Wired and wireless, Mobility of users and equipment, Electromagnetic Spectrum,
Radio and Microwave communication, Infrared and Millimeter waves, Legthwave Transmission.
Satellite Network Architecture-Satellite Orbits-GEO LEO, MEO. Inmarsat, Iridium, Odyssey, Global Star,
Archimedes and other Satellite Networks.
Spread Spectrum and CDMA-Direct (pseudo-noise) and Frequency hopped Spread Spectrum. CDMA System.
Wireless LANs -MACA and MACAW protocols. Infrared LAN. Cellular Radio Systems-Paging, Cordless
telephones, Analog Cellular telephones AMPS. Digital Cellular Telephone-GSM. Personal Communication
service (PCS).
CDPD system.
Mobile Data Networks and their applications.
Wireless and Mobile access to the Internet.

Text Books:
1. V. K. Garg & J. E. Wilks: Wireless and Personal Communication Systems: Fundamentals andApplications
IEEE Press and Prentice Hall, 1996.
2. T. S. Rappaport, B. D. Werner and J. H. Reed: Wireless Personal Communications: The Evolution of PCS,
Dkyener Academic, 1996.

Reference Books:
1. G. I. Stuber: Principles of Mobile Communication, Kluener Academic, 1996.
2. U. Black: Mobile and Wireless Networks, Prentice Hall PTR, 1996.

CSE 203	Elective – I	L-T-P : 3-1-0	Credit: 4	40L

CSE 204	Elective -II	L-T-P : 3-1-0	Credit: 4	40L

CSE 205	**Elective -III**	**L-T-P : 3-1-0**	**Credit: 4**	**40L**

CSE 211	**Advanced Computing and Communication Lab**	**L-T-P:0-0-6**	**Credit: 4**	**60P**

CSE 241	**Review Work and Seminar**	**L-T-P : NA**	**Credit: 6**	

Semester-III

CSE 301	**Elective - IV**	**L-T-P : 3-1-0**	**Credit: 4**	**40L**

CSE 302	**Elective - V**	**L-T-P : 3-1-0**	**Credit: 4**	**40L**

CSE 311	**Advanced Computing Lab - II**	**L-T-P : 0-0-6**	**Credit: 4**	**60P**

CSE 321	**Thesis - I**	**L-T-P : 0-0-20**	**Credit: 12**	

Semester-III

CSE 421	**Thesis - II**	**L-T-P : 0-0-24**	**Credit: 18**	

CSE 431	**Grand Viva**	**L-T-P : NA**	**Credit: 6**	

Elective Papers

Elective: IoT and Sensor Networks

Introduction to Sensor networks in smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security, IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, hardware, Data representation and visualization, Interaction and remote control.
Exemplary Device Board, Linux on Raspberry, Interface and Programming & IoT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases
Industrial Automation-Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation
Applications: Smart Grid &IoT, Healthcare, Industry automation, Commercial building automation using IoT, Smart cities, recent trends in sensor network and IoT architecture.

Books:
1. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publication

2. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things by Pearson Paperback – 16 Aug 2017 ,by Hanes David (Author), Salgueiro Gonzalo (Author), Grossetete Patrick (Author), Barton Rob (Author)

Elective: Machine Learning

Introduction; Learning Paradigms; Concept Learning.

Clustering methods, variants of K-means, hierarchical clustering, BIRCH, DBSCAN, Expectation-Maximization, Cluster Evaluation Techniques – Internal and External, clustering ensemble.
Linear Discriminant Analysis, Support Vector Machine, Naïve Bayes, Gradient Descent, Class Evaluation Measures, Overfitting, Bias Variance Trade-off Precision, Recall, F1 Score, ROC, AUC, Validation Strategies.
Neural Network, LTU, Perceptron, MLP, Activation Function, Loss Functions, Optimizers, Momentum Adadelta, RMSProp, Adam, Early Stopping, drop-out, Batch Normalization; Word Embedding, CboW, Skip-gram, Glove, ElMo, CNN, RNN, LSTM, GRU, Encoder-Decoder Network, Transfer, Auto Encoder, Generative Adversarial Network; Ensemble Methods - Bagging, Committee Machines and Stacking, Ensemble Methods – Boosting, Gradient Boosting; Undirected Graphical Models, Markov Chains, Random walk Monte Carlo, HMM, Variable elimination, belief propagation, Introduction to Reinforcement Learning, Sampling-based techniques, Q Learning, Introduction to XAI, Lime, SHAP etc. Learning from online streaming data, Machine Learning Applications.

Books:

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Second Edition. Feb 2009. Trevor Hastie, Robert Tibshirani, Jerome Friedman.
3. Introduction to Machine Learning, third edition. Ethem Alpaydin. The MIT Press. September 2014: ISBN: 978-0-262-028189

Elective: Theory of Computing

Concepts of structural program development; concept of data types; precedence and associatively of operators; conditional transfer; deterministic and in-deterministic loops; recursions; functions and procedures - call by value, call by reference and their differences; programming for numerical methods; records.
Data-type handling and various constructs (conditional, loop, functions etc); pointers: concept of pointers and passing parameters using pointers, non-numeric processing, concept of arrays of pointers and pointers to pointers; Structures and unions – advantage of using structures, concept of information hiding, pointers to structures; Files - basic concept of various types of file access methods: sequential, indexed sequential, random, various statements for file handling
Advanced Programming Languages like C++, ADA, LISP, PROLOG, and PASCAL. Comparison of various
languages

Text Books:

1. Tennence W.Pratt, “Programming languages design and implementation”, Prentice Hall of India.
2. Allen B. Tucker, “Programming Languages”, Tata McGraw Hill.

Reference Books:

1. Gottfried BS – Programming with C, TMH pub.
2. Balagurusamy:ANSI C TMH

Elective: Pattern Recognition

Introduction - Definitions, data sets for Pattern Recognition

Different Paradigms of Pattern Recognition
Representations of Patterns and Classes
Metric and non-metric proximity measures
Feature extraction, Different approaches to Feature Selection
Nearest Neighbor Classifier and variants
Efficient algorithms for nearest neighbour classification
Different Approaches to Prototype Selection
Bayes Classifier, Decision Trees, Linear Discriminant Function
Different Approaches to Prototype Selection, Bayes Classifier
Decision Trees, Linear Discriminant Function
Support Vector Machines, Clustering, Clustering Large datasets, Combination of Classifiers, Applications - Document Recognition.

Text Books:
1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.

Reference Books:
1. Pattern Recognition Paperback by Narasimha Murthy and Susheela Devi
2. Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher Bishop

Elective: Artificial Intelligence

Introduction – What is AI – Importance of AI – objectives.
Intelligent agents, state space representation, uninformed searches – BFS, DFS, IDS, informed and heuristic searches – Branch & bound, Best first, A* search; Local searches
and optimization, local and global optima, hill climbing, gradient descent, simulated annealing, genetic algorithms, Adversarial Search: Min-Max game tree
Knowledge – Its representation, Organization – Manipulation and Acquisition.
Predicate calculus in AI – First order predicate logic & its use in knowledge representation-Resolution principle. Use of resolution in reasoning and question answering.
Uncertainly Management-Fuzzy logic, Bayesian inferencing, dempster-shafer theory of beliefs, structured representation of knowledge- - Semantic networks, frames, conceptual dependency & scripts. Expert systems-rule based system architecture non-production system architecture-knowledge acquisition methods-Explanation methods-Expert system shells, Application of AI in natural language processing, speech understanding. Computer Vision, planning, etc.

Text Books:
1. George F. Luger, 'Artificial Intelligence – Structures and Strategies for Complex Problem Solving', Fourth Edition, Pearson Education, 2002.
2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence ,McGraw Hill Education (India) Private Limited; 3 edition

Reference Books:

1. Nils J. Nilsson, Principles of Artificial Intelligence (Symbolic Computation / Artificial Intelligence), Springer; Softcover reprint of the original 1st ed. 1982 edition
2. George F. Luger, Artificial Intelligence, Pearson Education; Fifth edition
3. Stuart Russell and Peter Norvig: Artifical Intelligence: A Modern Approach, Pearson; Third edition

Elective: Advanced Software Engineering

System Engineering - Analysis & Design
Software Architectures & Design.
Software Metrics.
Software Testing Strategies: Analytical models (e.g. Markov Chain Model, Probabilistic Models)
Software Reliability: Analytical Models
Formal Methods in Software Engineering (e.g. Formal Specification Language)
Software Re-use
Re-engineering - reverse engineering.
Real-time Software Engineering.
Client/Server Software Engineering.
CASE tool design & implementation.
Verification & Validation.
Object-oriented Software Engineering: OO-Analysis, OO-Design, OO-Testing, metrics for OO systems.
System Modeling and Simulation.
Software Engineering Economics.

Text Books:
1. Pressman: Software Engineering, McGraw Hill.
2. Shoeman: Software Engineering, McGraw Hill.
3. Ghezzi, Software Engineering, PHI

Reference Books:
1. Fundamentals of Software Engineering by Rajib Mall, PHI.
2. Sommerville, Ian – Software Engineering, Pearson Education

Elective: Advanced Network Security & TCP/IP Programming

Uniqueness – Number Theory concepts – Primality – Modular Arithmetic – Fermet & Euler Theorem – Euclid Algorithm – RSA – Elliptic Curve Cryptography – Diffie Hellman Key Exchange
Digests – Requirements – MAC – Hash function – Security of Hash and MAC – Birthday Attack –

MD5 – SHA – RIPEMD – Digital Signature Standard – Proof of DSSAuthentication applications – Kerberos – Kerberos Encryption Techniques – PGP – Radix64 – IP Security Architecture – Payload – Key management – Web security requirements – SSL – TLS – SET
Resources – Intruders and Intrusion – Viruses and Worms – OS Security – Firewalls – Design Principles – Packet Filtering – Application gateways – Trusted systems – Counter Measures
Protocols and standards – OSI model – TCP / IP protocol suite – addressing – versions – underlying technologies.
Classful addressing – other issues – subnetting – supernetting – classless addressing – routing methods – delivery – table and modules – CIDR – ARP package – RARP.
Datagram – fragmentation – options – checksum – IP package – ICMP – messages, formats – error reporting – query – checksum – ICMP package – IGMP – messages, operation – encapsulation – IGMP package – UDP – datagram – checksum – operation – uses – UDP package.
Services – flow, congestion and error control – TCP package and operation – state transition diagram – unicast routing protocols – RIP – OSPF – BGP – multicast routing – trees – protocols – MOSPF – CBT – PIM
Client server model – concurrency – processes – sockets – byte ordering – socket system calls – TCP and UDP client-server programs – BOOTP -DHCP – DNS – name space, resolution – types of records – concept – mode of operation – Rlogin.

Text Books:
1. “Network Security Essentials: Applications and Standards” by William Stallings, Pearson
2. “Network Security private communication in a public world”, C. Kaufman, R. Perlman and M. Speciner,
Pearson

Reference Books:
1. “Cryptography and Network Security”, William Stallings, 2nd Edition, Pearson Education Asia
2. “Designing Network Security”, Merike Kaeo, 2nd Edition, Pearson Books
3. “Building Internet Firewalls”, Elizabeth D. Zwicky, Simon Cooper, D. Brent Chapman, 2nd Edition, Oreilly
4. “Practical Unix & Internet Security”, Simson Garfinkel, Gene Spafford, Alan Schwartz, 3rd Edition, Oreilly

Elective: Blockchain Technology

Introduction of Cryptography and Blockchain: What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.
BitCoin and Cryptocurrency: What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency, Transactional Blocks, Impact Of Blockchain Technology On Cryptocurrency.

Introduction to Ethereum: What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts.
Introduction to Hyperledger: What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer.
Solidity Programming:
Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)
Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

Reference Books:
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Antonopoulos, Mastering Bitcoin.
3. Antonopoulos and G. Wood, Mastering Ethereum.
4. D. Drescher, Blockchain Basics. Apress, 2017.

Elective: Real Time & Embedded Systems

Real Time Systems, Specification, Analysis, Design. Definition, Types and Evolution; State Diagram, Finite Automata, Timed Petri Net, Formal Methods for Analysis & Design. Algorithm Development, Implementation of Real Time Algorithms Debugging and Verification Real Time Distributed Computing
Clock Synchronization, Real Time constraint satisfaction Reliability & Safety.
Case Studies Computer Control Systems Real Time Simulation Systems
Mission Control Systems Safety Critical Systems.

Introduction: Characteristics of embedded systems; Applications; Concept of real time systems; Challenges in embedded system design.
Embedded Processors: Review of structure of a basic computer system: CPU, memory, I/O devices on a bus; Memory System Mechanisms – Caches, Memory Management Units and Address Translation; I/O subsystem – input and output devices, busy-wait I/O, interrupt driven I/O; Interrupts – Basics, interrupt latency; Co-processors; Processor Performance Enhancement-Pipelining, Superscalar execution, caching.
The Embedded Computing Platform: Board Buses – Bus Arbitration and Timing; The CPU Bus; Memory Devices and their Characteristics – Random-Access memories, Read-Only memories; I/O devices – Timers and Counters, Watchdog timers, GPIO, A/D, D/A, Displays, Keyboards; Component Interfacing – Memory interfacing, device interfacing, interfacing protocols; Designing with processors – System architecture, Hardware design; Target Devices-FPGA, CPLD.
Embedded Software Architectures: Round-Robin; Round-Robin with Interrupts; FunctionQueue-Scheduling Architectures; Real-Time Operating System Architecture; Selecting an Architecture.

Real-time operating systems: Tasks and Task States; Tasks and Data; Context Switching-Cooperative multitasking, Preemptive multitasking; Scheduling Policies-Rate-Monotonic scheduling, Earliest-Deadline-First scheduling, RMS versus EDF; Semaphores and Shared Data; Message Queues; Timer Functions; Events; Memory Management; Priority Inversion; Interrupt Routines in an RTOS Environment.
Low-power computing: Sources of energy consumption: toggling, leakage – Instruction-level nstrategies for power-management: functional unit management - Memory system power consumption: caches, off-chip memory - Power consumption with multiple processes – Systemlevel power management: deterministic, probabilistic methods.
Hardware Accelerators: CPUs and Accelerators – Why Accelerators, Accelerator Design; Accelerated System Design – Performance Analysis, System Architecture Framework, Partitioning, Scheduling and Allocation, System Integration and Debugging. Networked embedded systems: Why networked embedded systems - Example networked embedded systems: automobiles, factory automation systems - Types of network fabrics - Network performance analysis - Internet-enabled embedded systems.
Design and Development of Embedded Systems: Creating an Embedded System Architecture; Implementing the Design - Embedded Software Development Tools, Host and Target Machines, Linker/Loader for Embedded Software, Getting Embedded Software into Target System, Debugging Techniques and Tools, Testing on the host machine, instruction set simulators, oscilloscopes, logic analyzers, in-circuit emulators, monitors, System Boot-Up; Quality
Assurance and Testing of the Design.

Text Books:

1.Frank Vahid, Tony Givargis: Embedded System Design: A Unified Hardware/Software Introduction, Wiley; Student edition (21 July 2006)
2. Mazidi M. Ali , Mazidi J. G., and Rolin McKinlay, The 8051 Microcontroller and Embedded Systems; Pearson; Second edition (2008)
3. Real-time Systems, Jane W. S. Liu
4. Real-Time Systems Design and Analysis, Philip A. Laplante
5. Real-time Systems, Hermann Kopetz

Reference Books :

1. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann; 2 edition (June 16, 2008)
2. David E. Simon, Embedded Software Primer,, Addison-Wesley Professional; 1 edition (August 15, 1999)
3. Raj Kamal: Embedded Systems ; McGraw-Hill Education (India); 2nd Edition (March 9, 2009)
4. Real-time Systems: Theory and practice, Rajib Mall
5. Real-Time Concepts for Embedded Systems, Caroline Yao, Li Zhang

Elective: Management Information Systems

Management activities, roles and levels

Management Planning and Control: how planning and control systems interrelate
Strategic Planning within an organization: activities, techniques and results
The nature of decision-making: decision-making models and classification of decision-making situations
Management as the direct user of an MIS vs Intermediary usage
Measurement of MIS performance and capabilities
Reporting Systems (MRS)
Decision Support Systems (DSS)
Office Information Systems (OIS) – including video conferencing and email
Knowledge based systems that support management such as Expert Systems (ES) and Neural Network (NN) Systems
The application of Online-Analytical Processing (OLAP)/Data Mining/Business Intelligence (BI) tools in supporting management decision making
The relationships of MIS to other enterprise applications, such as Transaction Processing Systems (TPS) and Enterprise Resource Planning (ERP) systems
IS within functional areas such as Human Resources, Marketing and Sales, Production, Accounting and Finance, Customer Relationship Management (CRM), Product Supply Chain Management Systems
The Internet and MIS provisions: Internet and the linkages to legacy MIS, Internet customer interfaces, security issues.
MIS and mobile computing
MIS and social media

Text Books:
1. Kenneth C. Laudon & Jane P. Laudon, Essentials of Management Information Systems, Tenth Edition, Pearson Prentice-Hall, 2012
2. Terry Lucy, Management Information Systems, Ninth Edition, 2005, Thompson

Reference Books:
1. McNurlin, Sprague & Bui, Information Systems Management in Practice, Prentice-Hall (8th Ed), 2013
2.Efraim Turban, Jay Aronson & Tin-Peng Liang, Decision Support Systems and Intelligent Systems, Ninth Internal Edition, Pearson Prentice Hall, 2010.

Elective: Optical Networks

Introduction to Optical Networks
Components
Transmitters
Transmission System Engineering
First Generation Networks
Wavelength Routing Networks
Virtual Topology Design
Access Networks

Text Books:
1. Optical networks: A practical perspective, Kumar Sivarajan and Rajiv Ramaswamy: Morgan Kauffman 1998.
2. Gigabit-capable Passive Optical Networks-D. Hood, Wiley

Reference Books:
1. Optical Communication Networks: Biswajit Mukherjee: TMG,1998.
2. Optical Networks, Ulysees Black: Pearson education 2007.

Elective: Cloud Computing

Introduction to cloud computing – Overview of Computing, Cloud Computing NIST Model, Properties, characteristics and disadvantages, role of open standards.
Cloud computing architecture – cloud computing stack, service Models (XaaS), IaaS, Paas, SaaS, Daas, Deployment Models, private, public, hybrid, commercial cloud models.
Service management in Cloud computing – service level agreement (SLA), SLA violation, cloud economics.
Resource management in cloud computing – resource sharing, scalability, elasticity, transparency.
Data management in cloud computing – looking at data scalability and cloud services, database and data stores in cloud, large scale data processing
Cloud security – infrastructure security, data security and storage, identity and access management, access control, trust, reputation risk
Cloud simulators – CloudSim, CloudAnalyst, MultiRecCloudSim, CloudSimPlus, GreenCloudSimulator
Research trend in Cloud compting, green cloud computing, fog computing

Text Books:
1. Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd, 2013
2. Mastering Cloud Computing by RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, McGraw Hill
3. Education (India) Private Limited, 2013

Reference Books:
1. Cloud computing: A practical approach, Anthony T. Velte, Tata Mcgraw-Hill
2. Cloud Computing, Miller, Pearson
3. Building applications in cloud:Concept, Patterns and Projects, Moyer, Pearson

Elective: Network Administration

Networking Overview • IP Addressing Basics • Active Directory • DHCP, DNS, FTP, HTTP etc. • Implementing and Managing WINS • Securing Network Traffic • Remote Access • Internet Authentication Service • Routing • Other related topics

Textbooks:

1. Hands-on Microsoft Windows Server 2003 Administration by Dan DiNicolo, Thomson Course Technology, ISBN: 0619186119;

2. MCSE Guide to Managing a Microsoft Windows Server 2003 Network, Enhanced by Jason W. Eckert and M. John Schitka, Thomson Course Technology, ISBN: 0619217537

Elective: High Performance Computing Architecture

Parallel Processing Concepts (Quick Overview): Levels of parallelism (instruction, transaction, task, thread, memory, function). Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc). Architectures: N-wide superscalar architectures, multi-core, multi-threaded

Parallel Programming with CUDA: Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture). Memory hierarchy and transaction specific memory design. Thread Organization

Fundamental Design Issues in Parallel Computing: Synchronization. Scheduling. Job Allocation. Job Partitioning. Dependency Analysis. Mapping Parallel Algorithms onto Parallel Architectures. Performance Analysis of Parallel Algorithms.

Fundamental Limitations Facing Parallel Computing: Bandwidth Limitations. Latency Limitations. Latency Hiding/Tolerating Techniques and their limitations

Power-Aware Computing and Communication: Power-aware Processing Techniques. Power-aware Memory Design. Power-aware Interconnect Design. Software Power Management

Advanced Topics: Petascale Computing. Optics in Parallel Computing. Quantum Computers. Recent developments in Nanotechnology and its impact on HPC

Reference Books:

1. "Highly Parallel Computing", by George S. Almasi and Alan Gottlieb
2. "Advanced Computer Architecture: Parallelism, Scalability, Programmability", by Kai Hwang, McGraw Hill 1993.
3. "Parallel Computer Architecture: A hardware/Software Approach", by David Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999.
4. "Scalable Parallel Computing", by Kai Hwang, McGraw Hill 1998.
5. "Principles and Practices on Interconnection Networks", by William James Dally and Brian Towles, Morgan Kauffman 2004.
6. GPU Gems 3 --- by Hubert Nguyen (Chapter 29 to Chapter 41).
7. Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Welsey, © 2003.
8. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, © 2007.

Elective: Web Mining and Internet Technology

Data integration for e-commerce, Web personalization and recommender systems, Web content and structure mining, Web data warehousing, Review of tools, applications, and systems, Data collection and sources of data, Data preparation for usage mining, Mining navigational patterns, Integrating e-commerce data, Leveraging site content and structure, User tracking and profiling, E-Metrics: measuring success in e-commerce, Privacy issues, Evolution of the Internet, Growth of the World Wide Web and Big Data, Client-server model, Architecture of the Intranet/Internet/Extranet, Access method: dialup, ISDN, ADSL/2+, cable, LAN, WiFi, Mobile and Satellite, Proxy Servers, Application areas: E-commerce, Education, Entertainment such as Games and Gambling
Internet of Things (IoT) Search Engines, Webbots, integrity of information, database online.

Text Books:
1. Presten Gralla and Michael Troller., How the Internet Works, Que, (8th Edition), 2006
2. Perry J. et al, The Internet – Illustrated Introductory, Course Technology (3rd Ed)
3. Bates, C., Web Programming: Building Internet Applications, John Wiley and Sons (3rd Ed), 2006.
4. Berners-Lee, T. et al, Weaving the Web, Harper Business, 2000

Reference Books:
1. Hofstetter, F.T., Internet Literacy, McGraw Hill (4th Ed), 2005
2. McGloughlin, S., Multimedia: Concepts and Practice, Prentice Hall, 2001.
3. Anderson, P., Web 2.0 and Beyond: Principles and Technologies, Chapman & Hall/CRC Textbooks in Computing, 2012
4. Bahga, A and Madisetti, V., Internet of Things: A Hands-On Approach, VPT, 2014

Elective: Authentication & Steganography

Introduction to Biometrics: Introduction, Physiological or Behavioral, Verification vs. Identification, Applications, Biometrics Technologies, Working of Biometrics, Benefits, Application Design.

Fingerprint Recognition: What Is Fingerprint Scanning? Practical Applications for Fingerprint Scanning, Accuracy and Integrity, Fingerprint Matching, Fingerprint Classification, Fingerprint Image Enhancement, Fingerprint Feature Extraction, Fingerprint Form Factors, Types of Scanners: Optical - Silicon – Ultrasound, Fingerprint Matching.

Speaker Recognition: Algorithms for training, recognition and adaptation to speaker and transmission channel, mainly based on Hidden Markov Models (HMM), methods for reducing the sensitivity to external noise and distortion, acoustic modeling of static and time-varying spectral properties of speech, statistic modeling of language in spontaneous speech and written text, specific analysis and decision techniques for speaker recognition.

Face Recognition: Introduction to Face Recognition, How is Face Recognition Technology Currently Being Used? How Well Does Face Recognition Work, Why Face Recognition, Face Recognition: How it Works, Image Quality, Facial Scan Process Flow, Verification vs. Identification, Primary Facial

Recognition Technologies, Facial Recognition Applications. Multi-Modal Biometrics: Introduction to Multi-Modal Biometric Systems, Fusion Methodology, Levels of Fusion, Feature-Extraction Level Fusion, Data-Matching Level Fusion, Probabilistic-Decision level Fusion, Fusion Procedure, Modes of Operation, Integration Strategies, Issues, Soft Biometrics, A Biometric Vision.

Text Books:
1. Guide to Biometrics (Springer Professional Computing) by R. Bolle, J. Connell, S. Pankanti, N. Ratha, Springer Press, 2003, ISBN0387400893
2. Biometrics Personal Identification in Networked Society, Jain, Bolle, Pankanti 1999
3. Handbook of Fingerprint Recognition, Maltoni, Maio, Jain, Prabhakar, 2005
4. Biometric Systems, Wayman, Jain, Maltoni and Maio 2004

Reference Books:
1. Fundamentals of Speech Recognition, L. Rabiner and B. Juang, , Pearson Education.
2. Speech and Audio Signal Processing, B. Gold and N. Morgan, John Wiley.
3. Spoken Language Processing, Huang, Acero & Hon, Prentice Hall, 2001.
4. Speech and Language Processing: An Intro to NLP, CL, and Speech Recognition (2nd Edition) Jurafsky & Martin, Prentice Hall, 2000.
5. Statistical Methods for Speech Recognition. Jelinek. MIT Press,
6. Fundamentals of Speech Recognition, Rabiner & Juang, Prentice-Hall,

Elective: Data Warehousing and Data Mining

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.
Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.
Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.
Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.
Classification and Prediction: - Issues Regarding Classification and Prediction – Nearest Neighbour Classification - Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification –Support Vector Machines – Associative Classification –Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.
Mining Object, Spatial, Multimedia, Text and Web Data:
Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Books:
1. Reema Thareja, “Data Warehousing”, Oxford University Press.

2. Jiawei Han and Micheline Kamber, “Data Mining Concepts & Techniques”, Elsevier Pub.
3. Margret H. Dunham “Data Mining: Introductory and Advanced topics” Pearson Education
4. Paulraj Ponniah, “Data Warehousing Fundamentals”, John Wiley & Sons, Inc.
5. Vikram Pudi, P. Radha Krishana “Data Mining”, Oxford University press.

Elective: Digital Image Processing

Introduction: Digital Image representation; Fundamental steps in Image processing, Elements of digital Image processing systems.
Digital Image Fundamentals: Sampling and quantization, imaging geometry.
Image Transforms: Fourier, Walsh, Hademord, discrete cosine and Hotelling transforms and their properties.
Image Enhancement: Enhancement by point processing, spatial filtering, Frequency domain enhancement, Color image processing.
Image Restoration: Unconstrained and constraint restoring, inverse filtering, Wiener Filter, Geometric transforms.
Image Compression: Image Compression models, Error-free compression, Lossy compression, Image compression standards.
Image Segmentation: Detection of discontinuities, edge linking, Thresholding.
Representations and Descriptions: Chain codes, shape numbers, moments and Fourier and other descriptors. Recognition & Interpretations.

Text Book:

1. Digital Image Processing, Gonzalves,Pearson
2. Digital Image Processing, Jahne, Springer India
3. Digital Image Processing &Analysis,Chanda&Majumder,PHI
4. Fundamentals of Digital Image Processing, Jain, PHI

References Books:

1. Image Processing, Analysis & Machine Vision, Sonka, VIKAS
2. Getting Started with GIS- Clarke Keith. C; PE.
3. Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.