RANI RASHMONI GREEN UNIVERSITY

TARAKESWAR, HOOGHLY

# CBCS SYLLABUS

# DEPARTMENT OF COMPUTER SCIENCE

## Syllabus for M.Sc. in Computer Science

**Duration: Two Years (Four Semesters)**

**Total Marks: 1100 (300 + 300 + 250 +250)**

**Total Credit Points: 88 (24 + 24 + 20 + 20)**

## Detailed course structure

| | Course Code | Course Title | Course Credit | Full Marks | L-T-P |
|---|---|---|---|---|---|
| SEM-I | MSCCS101 | Advanced Computer Architecture | 4 | 50 | 4-0-0 |
| | MSCCS102 | Advanced Data Structures and Algorithms | 4 | 50 | 3-1-0 |
| | MSCCS103 | Computer Network & Cyber security | 4 | 50 | 4-0-0 |
| | MSCCS104 | Theory of Computation | 4 | 50 | 4-0-0 |
| | EVS-CB11 | Introduction to Environmental Science | 4 | 50 | 3-1-0 |
| | MSCCS105 | Data Structures & Algorithms Lab | 2 | 25 | 0-0-2 |
| | MSCCS106 | Computer Network Lab | 2 | 25 | 0-0-2 |
| Total | | | 24 | 300 | |

| | Course Code | Course Title | Course Credit | Full Marks | L-T-P |
|---|---|---|---|---|---|
| SEM-2 | MSCCS201 | Soft Computing & AI | 4 | 50 | 3-1-0 |
| | MSCCS202 | Advanced Database Management Systems | 4 | 50 | 3-1-0 |
| | MSCCS203 | Compiler Design | 4 | 50 | 4-0-0 |
| | MSCCS204 | Data Science and Optimization Techniques | 4 | 50 | 4-0-0 |
| | EVS – CB21 | Environmental Management | 4 | 50 | 3-1-0 |
| | MSCCS205 | DBMS Lab | 2 | 25 | 0-0-2 |
| | MSCCS206 | Data Science and AI Lab | 2 | 25 | 0-0-2 |
| Total | | | 24 | 300 | |

| | Course Code | Course Title | Course Credit | Full Marks | L-T-P |
|---|---|---|---|---|---|
| SEM-3 | MSCCS301 | Digital Image Processing | 4 | 50 | 4-0-0 |
| | MSCCS302 | Introduction to Cryptography | 4 | 50 | 3-1-0 |
| | MSCCS303 | Advanced Software Engineering | 4 | 50 | 4-0-0 |
| | MSCCS304 | Machine Learning | 4 | 50 | 3-1-0 |
| | MSCCS305 | Machine Learning Lab | 2 | 25 | 0-0-2 |
| | MSCCS306 | Minor project | 2 | 25 | 0-0-2 |
| Total | | | 20 | 250 | |

| | Course Code | Course Title | Course Credit | Full Marks | L-T-P |
|---|---|---|---|---|---|
| SEM-4 | MSCCS401 | Cloud and Green Computing | 4 | 50 | 3-1-0 |
| | MSCCS402 | Elective E1 | 4 | 50 | 4-0-0 |
| | MSCCS403 | Grand Viva | 4 | 50 | 4-0-0 |
| | MSCCS404 | Major Project | 8 | 100 | 0-0-8 |
| Total | | | 20 | 250 | |

**Elective E1**: Distributed Systems/ VLSI Design/Deep Learning

| Semester | **I (ONE)** |
|---|---|
| Course Name & course code | **Advanced Computer Architecture (MSCCS101)** |
| Course content | **Module I**: Parallel processing: Parallel computer architecture, Flynn's classification (SISD, SIMD, MISD, MIMD structures); Applications of parallel processing. [4 L]<br>**Module II**: Concepts of Pipelining, pipeline scheduling, Arithmetic pipeline, Instruction set Pipelining, dynamic pipelining, pipelining Hazards, techniques for handling hazards. [8 L]<br>**Module III**: Array and Vector Processor: Vector processing principles, Instruction types, compound vector operation, vector loops and chaining, Array Processors: Structure : Systolic array processor [8 L]<br>**Module IV**: Systematic and distributed shred memory architecture, cache coherence issues, performance issues, synchronization issues, models of memory consistency, Interconnection networks, buses, crossbar and multistage switches. [10 L]<br>**Module V**: Design issues in parallel computing: Memory hierarchy and transaction specific memory design: Thread organization, synchronization, scheduling, Job Allocation, Job partitioning, dependency analysis, Mapping parallel algorithms onto parallel architectures. [10 L] |
| Books and references | 1. Kai Hwang, Advanced Computer Architecture, Tata Mc Graw Hills.<br>2. Parallel Computer Architecture: A Hardware/Software Approach, David E. Culler, Jaswinder Pal Singh, Anoop Gupta, Gulf Professional Publishing.<br>3. Kai Hwang and F. A. Briggs, Computer Architecture and Parallel Processing, Tata Mc Graw Hills<br>4. Hennessy Patterson, Computer Architecture, A quantitative Approach, 5th ed,Elsevier. |

| Semester | **I (ONE)** |
|---|---|
| Course Name & course code | **Advanced Data Structures and Algorithms (MSCCS102)** |
| Course content | **Module I**: Analysis of algorithms: Time and space complexities, asymptotic notation (big-Oh, big-Theta, big-Omega, small-oh and small-omega), Recurrence relations and solutions. [8L]<br>**Modulo II**: Sorting Algorithms: Heap sort, Radix sort, Shell sort, Count sort, Randomized quick sort.<br>**Module III**: Dynamic Programming: Longest common subsequence problem, Matrix, chain multiplication, Optimal binary search trees. [8L]<br>**Module IV**: Backtracking, Branch & Bound: 8 queen's problem, Travelling salesperson problem. [8L]<br>**Module V**: Tree & Graph Algorithms: BFS, DFS, minimal spanning tree, Bellman-ford algorithm, Floyd- Warshall algorithm, Topological sort, Red-black tree : properties, insertion and deletion. [8L]<br>**Module VI**: Computational complexity: P, NP and NP-completeness and reducibility, statement of cook's theorem, NP-complete problems: Clique, Vertex cover, Hamiltonian cycle.) [8L] |
| Books and references | 1. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, PrenticeHall of India, New Delhi, 1998.<br>2. Aho, J. Hopcroft and J. Ullman: The Design and Analysis of Computer Algorithms, A.W. L, International Student Edition, Singapore, 1998.<br>3. S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison-Wesley, California, 1988.<br>4. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub. |

| Semester | **I (ONE)** |
|---|---|
| Course Name & course code | **Computer Network and Cyber Security(MSCCS103)** |
| Course content | **Module I:** Routing algorithms: Shortest path first, Flooding, Distance vector routing, Link state routing, Hierarchical routing, Broadcast and Multicast routing. [6L]<br>**Module II:** Routing protocols: ARP, RARP, ICMP, RIP, OSPF, BGP [8L]<br>**Module III**: Congestion control techniques, congestion control in TCP, VLAN, VPN, and WLAN [6L].<br>**Module IV**: Threats and its types- Internal and External, introduction to cyber-security, McCumber's cube, cyber-warfare [3L]<br>**Module V** : Methods of infiltration: : Social Engineering, SEO (Search engine optimization) poisoning, Dos (Denial-of-serveice), DDoS, Botnet, wi-fi password cracking,password attacks, [7L]<br>**Module VI**: Attack Tools: Malware, spyware, adware, backdoor, ransomeware, scareware, rootkit, virus, Torjan Horse and worm; type of attackers: White hat, Gray Hat and black hat attackers [10L]. |
| Books & references | 1. Computer Networks — Andrew S Tanenbaum, 4th Edition. PearsonEducation/PHI<br>2. Data Communications and Networking – Behrouz A. Forouzan, Third EditionTMH.<br>3. Cybersecurity and Cyberlaw, Abraham Wagner, Nicholas Rostow<br>4. Security in Computing, Fourth Edition, by Charles P. Pfleeger, Pearson Education |

| Semester | **I (ONE)** |
|---|---|
| Course Name & course code | **Theory of Computation (MSCCS104)** |
| Course Content | **Module I: Regular Languages Introduction:** Regular Language Models: Deterministic Finite Automaton (DFA), Non-Deterministic Finite Automaton (NDFA), Equivalence of DFA and NDFA, Regular Languages, Regular Grammars, Regular Expressions, Properties of Regular Language, Pumping Lemma [12 L]<br>**Module II: Context Free Language:** Pushdown Automaton (PDA), Non-Deterministic Pushdown Automaton (NPDA), Context Free Grammar, Chomsky Normal Form, Greibach Normal Form, Ambiguity, Parse Tree Representation of Derivation Trees, Equivalence of PDA's and Context Free Grammars; Properties of Context Free Language. [18L]<br>**Module III: Turing Machines (TM):** Standard Turing Machine and its Variations; Universal Turing Machines, Models of Computation and Church-Turing Thesis; Recursive and Recursively Enumerable Languages; Context-Sensitive Languages, Unrestricted Grammars, Chomsky Hierarchy of Languages, Construction of TM for Simple Problems. [10L] |
| Books and references | 1. John E. Hopcroft, Rajeev Motwani and Jeffery D. Ullman, Automata Theory.<br>2. Languages, and Computation (3rd. Edition), Pearson Education, 2008.<br>3. Michael Sipser, Introduction to the Theory of Computation, Books/Cole ThomsonLearning, 2001.<br>**4.** JE Hopcroft and JD Ullman, Introduction to Automata Theory, Languages, and Computation, Addison-Wesley, 1979. |

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|---|---|
| Semester | **I (ONE)** |
| Course Name & course code | **Introduction to Environmental Science (EVS-CB11)** |
| Course Content | **Unit-1**: Basic concept of environment Basic concepts of environment and environmentalism, Environmental education and awareness, Environmental ethics and global imperatives, Basic concept of sustainable development.<br>**Unit -2**: Ecosystems and Ecology Ecosystems: types, structures and function. Energy f low in ecosystem, Biogeochemical cycle, Population and Community ecology, Niche and Habitat concept, Succession, Biodiversity and Conservation Biology.<br>**Unit-3**: Energy and Environment Energy Environment and Society, Renewable and Non-renewable energy resources, Types of Alternative energy, Energy security and EnergyAudit.<br>**Unit -4**: Green Technology, Applications of Green Technology, Green infrastructure, Green Chemistry, Green planning and economy.<br>**Unit -5**: Current Environmental Issues in India. Environmental movements and related issues, Water, Energy and Waste management issues, Joint Forest Management, Man-animal conflict, Ecological restorations, Environmental pollution, Extreme weather events, Land use related issues |

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|---|---|
| Semester | **I (ONE)** |
| Course Name & course code | **Data Structures and Algorithms Lab (MSCCS105)** |
| Course content | **Sample programs :**<br>1. Implement Heap sort, Radix sort, Shell sort,Count sort, Randomized quick sort.<br>2. Implement matrix-chain multiplication<br>3. Implement graph based algorithms: Bellman-Ford, Floyd-Warshall all pair shortest path algorithm.<br>4. Write a program to determine the LCS of two given sequences.<br>5. Implement graph traversal algorithms (BFS,DFS).<br>6. Implement minimum spanning tree of a graph using Prim's and Kruskal's algorithm. |

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|---|---|
| Semester | **I (ONE)** |
| Course Name & course code | **Computer Network Lab (MSCCS106)** |
| Course content | **Sample programs :**<br>1. Implement the different routing algorithms: Shortest path first, Flooding, Distance vector routing, Link state routing etc.<br>2. Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channel.<br>3. Simulate parity check method for odd no. of error detection.<br>4. Simulate Hamming-code based error detection & correction algorithm for noisy channel.<br>5. Simulate and implement stop and wait protocol for noisy channel.<br>6. Simulate and implement go-back-N sliding window protocol.<br>7. Implement the following functions: socket, connect, bind, listen and accept. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Artificial Intelligence and Soft computing (MCSCS201)** |
| Course Content | **Module I: Introduction:** Definition, Goal, Importance, History, Applications,Components and Branches of Artificial Intelligence (AI) Turing Test. [3L]<br>**Module II: Agents and Environments:** Introduction, Concept of Rationality, Typesof Agents, Types and Properties of Environments. [2L]<br>**Module III: Search Strategies:** Search Methods, Uninformed Search (BFS, DFS, Uniform Cost, Depth limited, Iterative Deepening, Bidirectional), Informed Search Methods (Hill climbing, Best First, A*, and AO*, Simulated Annealing, Branch andBound), Adversarial Search, Game Playing, Min-Max Search, Alpha Beta Cutoff Procedures. [8L]<br>**Module IV: Predicate Logic in AI:** First Order Predicate Logic and its use in knowledge representation, Resolution Principle. Use of Resolution in reasoning and question answering, Knowledge Representation: Logic, Semantic Networks, Frames, Rules, Scripts, Conceptual Dependency and Ontologies; Expert Systems, Handling Uncertainty in Knowledge. [12L]<br>**Module V**: **Sets:** Notion of Fuzziness, Membership Functions, Fuzzification and Defuzzification; Operations on Fuzzy Sets, Fuzzy Functions and Linguistic Variables;Fuzzy Relations, Fuzzy Rules and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule Based Systems. [8L]<br>**Module VI: Genetic Algorithms (GA):** Encoding Strategies, Genetic Operators, Fitness Functions and GA Cycle; Problem Solving using GA. [7L] |
| Books and References | 1. Artificial Intelligence – Making a System Intelligent by Dr. Nilakshi Jain,Wiley<br>2. Introduction to Artificial Intelligence & Expert System by D.W. Patterson,PHI<br>3. Introduction to Artificial Intelligence by Rich & Knight.<br>4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis &Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Advanced Database Management System (MCSCS202)** |
| Course Content | **Module I**: Functional Dependencies and Normalization (3NF, 4NF, 5NF) . [8L]<br>**Module II**: Query processing and optimizations: Steps of query processing, query interpretation, equivalence of expression, estimation of cost, join strategies. [8L]<br>**Module III**: Transaction processing and concurrency control: Transaction and schedule; ACID property, Serializability, Anomalies with interleaved execution, Conflict and View serializability; Concurrency control techniques: Locking and Timestamp based protocols, Multi-version and validation based schemes, multiple granularity locking, deadlock handling, Crash recovery: ARIES, Recovery data structure Log, Write ahead logging, Check-pointing, Recovery from a system crash. [8L]<br>**Module IV**: Distributed Database: Distributed database system, Distributed database design, Data fragmentation, Data replication, Data allocation, Query processing in distributed databases. [8L]<br>**Module V**: NoSQL: Different NoSQL Products, Querying and managing NoSQL, Indexing and Ordering Data sets. [8L] |
| Books and References | 1. Elmasri,Navathe,Fundamentals of Database System,3/e,Pearson Education.<br>2. Korth, Silberschatz : Database System Concepts, McGrawHill .<br>3. Ozsu,Principals of Distributed Database System,Pearson Education.<br>4. Ceri and Pelagatti, Distributed Databases: Principles and System: McGrawHill<br>5. T.J.Teorey - Database Modeling & Design, 3rd edition, Harcourt Asia Pte. Ltd.,New Delhi, 2002. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Compiler Design (MCSCS203)** |
| Course Content | **Module I:** Introduction to compiler**,** types of compiler, difference between compiler and interpreter, introduction to loader, linker, assembler and cross assembler. [3L]<br>**Module II: Syntax Analysis:** Associativity, Precedence, Grammar Transformations, Top Down Parsing, Recursive Descent Predictive Parsing, LL(1) Parsing, Bottom up Parsing, LR Parser, LALR(1) Parser. [8L]<br>**Module V: Semantic Analysis:** Attribute Grammar, Syntax Directed Definitions, In heritedand Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L- attributed Definitions; Type-Checking. [8L]<br>**Module VI: Run Time System:** Storage Organization, Activation Tree, Activation Record, Stack Allocation of Activation Records, Parameter Passing Mechanisms, Symbol Table. [8L]<br>**Module VII: Intermediate Code Generation:** Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls. [8L]<br>**Module VIII: Code Generation and Code Optimization:** Control-flow, Data-flowAnalysis, Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization, Instruction Scheduling. [5L] |
| Books and References | 1. JE Hopcroft and JD Ullman, Introduction to Automata Theory, Languages, and Computation, Addison-Wesley, 1979.<br>2. Aho, Sethi, Ullman – "Compiler Principles, Techniques and Tools" - PearsonPublication.<br>3. Compiler Design in C: Holub, PHI. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Data Science and Optimization techniques (MCSCS204)** |
| Course Content | **Module I**: Introduction to Statistics; Measures of Central Tendency: Mean, Median, Mode and other measures; Measures of Dispersion: Range, standard deviation, variance and other measures. [8L].<br>**Module II**: Introduction to probability: sample space, events, conditional probability. [2L]<br>**Module III**: Introduction to Data Science and its applications; Importance of Data Visualization and its types: Charts, Graphs, Tables, Maps and Histogram; Exploratory Data Analysis: Univariate Analysis, Multivariate Analysis [13L].<br>**Module IV**: Ethics in Data Science; Data Governance; Data Privacy; Introduction to Big Data [3L].<br>**Module V**: Optimization: Linear Programming - Mathematical Model, Graphical Solution, Simplex and Dual Simplex Method, Sensitive Analysis; Integer Programming, Transportation and Assignment Models, PERT-CPM: Diagram Representation, Critical Path Calculations and Resource Levelling, Cost Consideration in Project Scheduling [14L]. |
| Books and References | 1. N.G.Das, Statistical Methods, McGraw Hill Education, 1st edition.<br>2. D. Cielen, A.D.B. Meysman and Mohamed Ali, Introduction to Data Science.<br>3. N.C.Das, Data Science for Profesionals, SPD.<br>4. GS Sandhu, Linear Programming, First world publications. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Environmental Management(EVS – CB21)** |
| Course Content | **Unit 1**: Natural Resource Management and Sustainability<br>Concept of natural resources; Water resources; Mineral resources; Energy resources; Land resources; Forest resources; Bio-resources and management; Sustainable use of resources.<br>**Unit 2**: Waste Management, Solid, liquid and gaseous waste; Pollution from untreated waste disposal/discharge, Toxic effects of waste; Waste segregation, handling and management, Analysis and treatment of wastes, Domestic and industrial waste management, Resource recovery and reuse, Waste to energy; Zero liquid discharge concept, Laws and policies for pollution prevention and waste management.<br>**Unit 3**: Urban Ecosystem and Management, Urbanization; Development induced population displacement, Environment in an urban setting, Urban dwelling, Heat islands, Urban interface with the environment, Natural spaces in a city; Pollution due to population explosion and habitat degradation; Planning and environmental management.<br>**Unit 4**: Hazards and Disaster Management ,Hazards, disasters, risks and vulnerability; Earthquake, flood, cyclone and tsunami; Mitigation and preparedness; Disaster management; National policies and programs;Role of local bodies; Case studies on major natural disasters.<br>**Unit 5**: Regulations for Environmental, Management Environmental Impact Assessment-regulations, notifications and amendments, Environmental monitoring and role of regulatory agencies, Coastal regulatory zones, Special economic zones, Environmental audit, Corporate Environment al responsibility. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Advanced Database Management Systems Lab (MSCCS205)** |
| Course Content | **Module I**: Introduction to SQL constructs. Review of Basic SQL statements Select, Project, Join, Describing Oracle tables, restricting row returns Creating basic reports, Using the set commands, Adding prompts to queries.<br>**Module II**: Joining Oracle tables -Equi-join, Outer join Hiding joins by creating views, Using IN, NOT IN, EXISTS and NOTEXISTS, Subqueries, Exercise – write a subquery, Correlated subquery, Noncorrelated subqueries .<br>**Module III:** Advanced SQL operators -Between operator, IN and NOT IN operators, Sub-queries-EXISTS clause, Using wildcards in queries (LIKE operator),Aggregation in SQL - Count(*),Sum, Avg, Min and max. Using the group by clause, SQL access methods, Review of Basic joining methods-Merge join, Hash Join, Nested Loop join.<br>**Module IV:** Introduction to PL/SQL. |

| Semester | **II (TWO)** |
|---|---|
| Course Name & course code | **Data Science & AI Lab (MSCCS206)** |
| Course Content | **Sample Programs:**<br>1. Fifteen students were enrolled in a course. There ages were: 20 20 20 20 20 21 21 21 22 22 22 22 23 23 23.<br>i. Find the median age of all students under 22 years , ii. Find the median age of all students.<br>iii. Find the mean age of all students , iv. Find the modal age for all students<br>v. Two more students enter the class. The age of both students is 23. What is now mean, mode and median?<br>2. Following table gives a frequency distribution of systolic blood pressure. Compute all the measures of dispersions. |

| Midpoint | 95.5 | 105.5 | 115.5 | 125.5 | 135.5 | 145.5 | 155.5 | 165.5 | 175.5 |
|---|---|---|---|---|---|---|---|---|---|
| Number | 5 | 8 | 22 | 27 | 17 | 9 | 5 | 5 | 2 |

| Semester | **III (THREE)** |
|---|---|
| Course Name & course code | **Digital Image Processing (MSCCS301)** |
| Course Content | **Module I: Introduction:** Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display. [4L]<br>**Module II: Digital Image Formation:** A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform. [4L]<br>**Module III: Image Enhancement:** Mathematical Preliminaries: Neighbour of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of The Two-Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform [8L]<br>**Module IV: Image Enhancement:** Spatial Domain Method, Frequency Domain Method, Contrast Enhancement -Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. High-pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain - Low pass filtering, High pass filtering. [8L]<br>**Module V: Image Restoration:** Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Geometric Transformation - Spatial Transformation, Gray Level Interpolation. [8L]<br>**Module VI: Image Segmentation:** Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging. [8L] |
| Books and references | 1. Digital Image Processing; by Gonzalez, Woods, Eddins; Pearson Publication<br>2. Fundamentals of Digital Image Processing; by Anil K Jain; PHI Publication<br>3. Arthur Weeks, Fundamentals of Electronic Image Processing, PHI |

| Semester | **III (THREE)** |
|---|---|
| Course Name & course code | **Introduction to Cryptography (MSCCS302)** |
| Course Content | **Module I**: Introduction to security, brief history of cryptography, understanding attacks, services, mechanisms, security attacks, security services, model for network security, internet standards, Basic principles of good cryptosystems, Modular arithmetic and GF(2), substitution and transposition ciphers, Stream ciphers, Pseudo Random Number generators. [6L]<br>**Module II**: Symmetric block ciphers, DES, Gallois field, polynomial arithmetic, AES, Principles of S Box design, Block cipher design principles, Other Block ciphers.[4L]<br>**Module III**: Introduction to public key cryptography, Number theoretic foundations, public key cryptography principles, RSA encryption system, primality testing, Number theoretic algorithms, Attacks on RSA. Discrete Logarithm and Diffie- Hellman Key exchange, ElGamal system, Digital Signature, RSA and ElGamal based Digital signature, DSA, different attacks on digital signatures. [10L]<br>**Module IV**: Secure hash functions, Understanding Collisions, Secure Hash Algorithms-SHA, HMAC, key management, Digital Certificates. [8L]<br>**Module V:** Network Security: Security layers in Network Protocol Stack, IP Sec, Secure Socket Layer, Security protocols used in Application layer like PGP, SHTTP etc., Network Defence tools – Firewalls, Intrusion Detection. [12L] |
| Books and references | 1. Digital Image Processing; by Gonzalez, Woods, Eddins; Pearson Publication.<br>2. Fundamentals of Digital Image Processing; by Anil K Jain; PHI Publication.<br>3. Arthur Weeks, Fundamentals of Electronic Image Processing, PHI. |

| Semester | **III (THREE)** |
|---|---|
| Course Name & course code | **Advanced Software Engineering (MSCCS303)** |
| Course Content | **Module I: Software Design:** Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Cohesion and Coupling; Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design. [4L]<br>**Module II: Estimation and Scheduling of Software Projects:** Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing; Time-line Charts. [4L]<br>**Module III: Software Testing:** Verification and Validation; Error, Fault, Bug and Failure; Unit and Integration Testing; White-box and Black-box Testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing; Regression Testing, Performance Testing, Stress Testing. [8L]<br>**Module IV: Software Quality:** McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance, Risk Management, Risk Mitigation, Monitoring and Management (RMMM); Software Reliability. [4L]<br>**Module V: Software Configuration Management:** Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering. [4L]<br>**Module VI: Agile:** Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stakeholders, Challenges, Twelve Practices of XP, Scrum Practices, Applying Scrum. Need of scrum, working of scrum, Agile Testing Techniques, Test -Driven Development, User Acceptance Test. [8L]<br>**Module VII: Web Engineering**: Attributes of web-based applications, the WebE process, a framework for WebE, formulating, analyzing web-based systems, design and testing for web-based applications, Management issues. [4L]<br>**Module VII: Reengineering**: Business process reengineering, software reengineering, reverse reengineering, restructuring, forward reengineering,Economics of reengineering[5L]. |
| Books and references | 1. Roger S. Pressman, Software Engineering - A Practitioner's Approach, McGraw- Hill<br>2. Somerville, Software Engineering, Pearson Education<br>3. Jalote, Software Engineering, Narossa Publication<br>4. Robert C. Martin ,Agile Software Development, Principles, Patterns, and Practices<br>5. Succeeding with Agile : Software Development Using Scrum, Pearson (2010) |

| Semester | **III (THREE)** |
|---|---|
| Course Name & course code | **Machine Learning (MSCCS304)** |
| Course Content | **Module I:** Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. [4L]<br>**Module II:** Supervised learning (Classification): Concept of supervised learning, Logistic Regression, Multivariate Regression Analysis, Support Vector Machine, Kernel function and Kernel SVM. [10L]<br>**Module III:** Instance based learning, Feature reduction, Collaborative filtering-based recommendation Probability and Bayes learning. [6L]<br>**Module IV:** Unsupervised learning (Clustering): Concept of unsupervised learning, k-means, adaptive hierarchical clustering. [6L]<br>**Module V:** Neural network: Perceptron, multilayer network, backpropagation. [8L]<br>**Module VI:** Deep Learning: introduction to deep neural network, convolutional neural network (CNN) [6L] |
| Books and references | 1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.<br>2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin<br>3. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das,Pearson.<br>4. Deep Learning, Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra, Pearson. |

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|---|---|
| Semester | **III (THREE)** |
| Course Name & course code | **Machine Learning Lab(MSCCS305)** |
| Course Content | Exercises to solve the real-world problems using the following machine learning methods: Linear Regression ,Logistic Regression, Multi-Class Classification , Support Vector Machines  K-Means Clustering & PCA ,Develop programs to implement Anomaly Detection & Recommendation Systems. |

**MSCCS306**: Minor Project

| | |
|---|---|
| Semester | **IV (FOUR)** |
| Course Name & course code | **Cloud and Green Computing (MSCCS401)** |
| Course Content | **Module-I: Cloud Computing Overview:** Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self-service, Broad network access, Location independent resource pooling, Rapid elasticity, Measured service, Comparing cloud providers with traditional IT service providers, Roots of cloud computing. [8L]<br>**Module-II: Cloud Architecture:** Layers and Models Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service ( PaaS ), features of PaaS and benefits, Infrastructure as a Service ( IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing. [12L]<br>**Module-III: Virtualization and Abstraction:** What is Virtualization and how abstraction is provided in cloud? Advantages and Disadvantages, Types of Hypervisor, and Load balancing. [4L]<br>**Module-IV: Cloud Platforms and Applications:** Overview on Amazon Web Services, Google App Engine and Microsoft Azure [4L]<br>**Module-V: Green Computing:** Introduction to Green Computing & Background, Logistics,, Greening Data Centers and Servers, Green cloud architecture, Energy Management in Mobile Systems and Smartphones, Efficient Networking and Communication, Energy Management in Smart Homes, Security and Privacy [12L] |
| Books and references | 1. The Green Computing Book: Tackling Energy Efficiency at Large Scale by Wu Chun Feng.<br>2. Green Computing: Tools and Techniques for Saving Energy, Money, and Resourcesby Bud E. Smith<br>3. Judith Hurwitz, R Bloor, M.Kanfman, F.Halper “Cloud Computing for Dummies”, Wiley India Edition, First Edition<br>4. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, ”Cloud Computing:Principles and Paradigms”, Wiley Publication,2011. |

| Semester | **IV (FOUR)** |
|---|---|
| Course Name & course code | **Elective E1 (MSCCS402) : Distributed Systems** |
| Course Content | **Module I:** Introduction, definition, goals, advantages-disadvantages, Hardware and software concepts, design issues.[3L]<br>**Module II**: Synchronization: clock synchronization, and related algorithms, mutual exclusion, deadlock in distributed systems. [7L]<br>**Module III**: Shared memory: introduction, general architecture of DSM, design and implementation issues of DSM, different protocols in DSM. Naming overview. [10L]<br>**Module IV**: Processes: Threads, system model, processor allocation, scheduling, load balancing and load sharing; Fault tolerance system [10L].<br>**Module V**: Communication: Computer network and layered protocols, message passing, synchronization, Client-server model, remote procedure call (RPC) [10L]. |
| Books and references | 1. Tanenbum,A.S.,Distributed Operating Systems ,Pearson Education.<br>2. Singhal,Shivaratri,Advanced Concepts in Operating Systems,TMH.<br>3. P.K.Sinha,Distributed Operating Systems,PHI |

| Semester | **IV (FOUR)** |
|---|---|
| Course Name & course code | **Elective E1 (MSCCS402) : VLSI Design** |
| Course Content | **Module I:** Introduction to VLSI System Design**:** MOS Devices, Circuits and Fabrication, Design Principles and Characteristics of MOS Devices in Logic Circuits, Logic Implementation with nMOS, pMOS, CMOS, and PLAs, Pass and Transmission Logic of Transistors, Size and Complexity of Integrated Circuits, Feature Size, Impact of Shrinking, Clocking, Scaling, PLA Minimization and Folding, Inverters and Logic Gates, Design Rules and Layouts, Stick Diagram, Transistor Sizing. [10L]<br>**Module II:** Logic Design**:** Static nMOS and CMOS Circuits, Steering Logic, Dynamic CMOS Circuits, Static vs. Dynamic CMOS Designs, Domino and NORA Logic Circuits, Charge Sharing, Clock Generation and Distribution, Transmission Gates. [8L]<br>**Module III:** VLSI Design Process**:** System Specification, Functional Design, Logic Design, Circuit Design, Physical Design, Verification, Fabrication and Packaging. [5L]<br>**Module IV:** Design Styles**:** Custom Design, Standard-Cell Design, Gate-Array Design, FPGA, and MCMs. [5L]<br>**Module V:** Physical Design Issues**:** Partitioning, Floor-Planning and Placement, Routing, Compaction, Complexity Issues, Algorithms and Data Structures for Layout Designs. [12L] |
| Books and references | 1. Principles of CMOS VLSI Design. N. Weste and K. Eshraghian. Addison Wesley; 2nd edition (December 20, 2000).<br>2. Basic VLSI Design. D. A. Pucknell and K. Eshraghian. Pearson College Div., Subsequent edition (January 1, 1995).<br>3. An Introduction to VLSI Physical Design. M. Sarrafzadeh and C. K. Wong. McGraw-Hill College (February 21, 1996).<br>4. Algorithms for VLSI Physical Design Automation. N. A. Sherwani. Springer; 3rd edition (November 30, 1998).<br>5. Multi-Layer Channel Routing: Complexity and Algorithms. R. K. Pal. Narosa, 1st edition (September 28, 2000). |

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|---|---|
| Semester | **IV (FOUR)** |
| Course Name & course code | **Elective E1 (MSCCS402) : Deep Learning** |
| Course Content | **Module I:** Introduction: Introduction: Various paradigms of earning problems, Perspectives and Issuesin deep learning framework, review of fundamental learning techniques. [3L]<br>Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Softmax. [2L]<br>**Module II**: Artificial Neural Networks: Introduction, Perceptron Training Rule. Gradient Descent,Stochastic Gradient Descent, Backpropagation, Some problems in ANN. [4L]<br>**Module III:** Optimization and Regularization: Overfitting and Capacity, Cross Validation, FeatureSelection, Regularization, Hyperparameters. [4L]<br>**Module IV**: Convolution Neural Networks: Introduction to convolution neural networks: stacking,striding and pooling, CNN applications. [8L]<br>**Module V**: Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2SeqRNNs, LSTM, RNN applications. [6L]<br>**Module VI: Generative** models: Restrictive Boltzmann Machines (RBMs), Stacking RBMs, Belief nets,Learning sigmoid belief nets, Deep belief nets, Autoencoders. [7L]<br>Deep Learning Tools: Caffe, Theano, Torch. [6L] |
| Books and references | 1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.<br>2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.<br>3. Deep Learning, Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra, Pearson.<br>4. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.<br>5. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.<br>6. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004. |

**MSCCS403: Grand Viva**

**MSCCS404: Major project**