CBCS SYLLABUS

DEPARTMENT OF COMPUTER SCIENCE

SYLLABUS FOR M. Sc. (COMPUTER SCIENCE) COURSE

(EFFECTIVE FROM ACADEMIC SESSION: 2021 – 2022

Duration:	**Two Years (Four Semesters)**
Total Marks:	**1100 (300 + 300 + 250 +250)**
Total Credit Points:	**88 (24 + 24 + 20 + 20)**

Course Name: M.Sc in Computer Science

Detailed Course Structure

	Paper Code	Paper Title	Course Credits	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	Advanced Database Management System	**4**	**50**	**4-0-0**
	MSCCS104	Theory of Computation and Compiler Design	**4**	**50**	**3-1-0**
	EVS-CB11	Introduction to Environmental Science	**4**	**50**	**3-1-0**
	MSCCS105	Advanced Data Structures and Algorithms Lab	**2**	**25**	**0-0-2**
	MSCCS106	Advanced Database Management System Lab	**2**	**25**	**0-0-2**
Total			**24**	**300**	

1. Lecture Series: Python Programming (8 hours) (Attendance is compulsory)

	Paper Code	Paper Title	Course Credits	Marks	L-T-P
SEM-2	MSCCS201	Artificial Intelligence and Soft Computing	4	50	3-1-0
	MSCCS202	Advanced Computer Networks	4	50	3-1-0
	MSCCS203	Advanced Operating system	4	50	4-0-0
	MSCCS204	Discrete Structures and Optimization	4	50	4-0-0
	EVS – CB21	Environmental Management	4	50	3-1-0
	MSCCS205	Advanced Operating System Lab	2	25	0-0-2
	MSCCS206	Advanced Computer Networking Lab	2	25	0-0-2
Total			24	300	

Lecture Series: 2.1 Big Data (4 hours) **(Attendance is compulsory)**

2.2 Internet of Things (4 hours)

	Paper Code	Paper Title	Course Credits	Marks	L-T-P
SEM-3	MSCCS301	Image Processing	4	50	4-0-0
	MSCCS302	Cryptography and Network Security	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	

Lecture Series: 3.1 Deep Learning (4 hours) **(Attendance is compulsory)**

3.2 Blockchain Technology (4 hours)

	Paper Code	Paper Title	Course Credits	Marks	L-T-P
SEM-4	**MSCCS401**	Green Computing	**4**	**50**	**3-1-0**
	MSCCS402	Electives E1	**4**	**50**	**4-0-0**
	MSCCS403	Electives E2	**4**	**50**	**4-0-0**
	MSCCS404	Major Project Work	**8**	**100**	**0-0-8**
Total			**20**	**250**	

Lecture Series: 4.1 Embedded System (4 hours) **(Attendance is compulsory)**

4.2 Computer Vision (4 hours)

Semester – I

Course Name: Advanced Computer Architecture

Course Code: MSCCS101

Module I: Central Processing Unit: General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, RISC Computer, CISC Computer. [4L]

Module II: Memory Hierarchy: Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware. [4L]

Module III: Pipelining: Concepts of Pipelining, pipeline scheduling, Arithmetic pipeline, Instruction set Pipelining, dynamic pipelining, pipelining Hazards, techniques for handling hazards, flynn's classification. [8L]

Module IV: Array and Vector Processors: Vector Processing Principles, Instruction types, Compound vector operation, Vector Loops, and Chaining. Array Processors- Structure: Systolic array processor. [5L]

Module V: Multiprocessors: Symmetric and distributed shared memory architectures, Cache coherence issues, Performance Issues, Synchronization issues, Models of Memory Consistency, Interconnection networks, Buses, crossbar and multi-stage switches. [8L]

Module VI: Parallel Processing Concepts : 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 Processor Architecture. [5L]

Module VII: 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, Open MP/Python Multithread Programming. [6L]

Books and References:

1. Kai Hwang, Advanced Computer Architecture, Tata Mc Graw Hills
2. Parallel Computer Architecture: A Hardware/Software Approach, David E. Culler, Jaswinder Pal Singh, Anoop Gupta, Gulf Professional Publishing.
3. Kai Hwang and F. A. Briggs, Computer Architecture and Parallel Processing, Tata Mc Graw Hills
4. Hennessy Patterson, Computer Architecture, A quantitative Approach, 5th ed, Elsevier.
5. High Performance Computing, K. A. Dowd, Michael Kosta Loukides, O Reilly.
6. Introduction to Parallel Computing, By Ananth Grama et. al, Addison-Wesley.
7. Superscalar Microprocessor Design, Mike Johnson, Prentice Hall.
8. Dongarra, Foster, Fox & others, Source Book of parallel Computing, Elsevier.

Course Name: Advanced Data Structures and Algorithms

Course Code: MSCCS102

Module-I: Data Structures: Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Sorting and Searching Algorithms; Hashing: Hash table, hash function, open addressing, uniform hashing, universal hash functions, Perfect hashing. [5L].

Module-II: Performance Analysis of Algorithms and Recurrences: Time and Space Complexities; Asymptotic Notation, Recurrence Relations. [5L]

Module-III: Greedy Algorithm: Dijkstra's shortest path algorithm, Minimum Spanning tree (Prim's, Kruskal's), Activity Scheduling, Huffman coding, Disjoint set data structure and amortized analysis. [7L]

Module-IV: Dynamic Programming: Longest common subsequence problem, Matrix Chain multiplication, All pair shortest path, Knapsack problem, Optimal binary search tree. [5L]

Module-V: Backtracking, Branch and Bound: 3 colouring problem, 8-queens problem, knapsack problem. [4L]

Module-VI: NP Completeness: Informal concepts of deterministic and nondeterministic algorithms, P and NP, NP-completeness and reducibility, statement of Cook's theorem, some standard NP-complete problems- Clique, Travelling salesman problem, Vertex cover, Hamiltonian Cycle, 3-coloring problem. [8L]

Module-VII: Graph Algorithms: Topological sort, strongly connected components. MST using Prim's and Kruskal's algorithm (with proof of optimality). Single source shortest path: Bellman- Ford and Dijkstra's algorithms, All-pair shortest paths: Floyd-Warshall algorithm. Maximum flow: Ford-Fulkerson method. [6L]

Books and References:

1. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998.
2. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson New International Edition.
3. Aho, J. Hopcroft and J. Ullman: The Design and Analysis of Computer Algorithms, A. W. L, International Student Edition, Singapore, 1998.
4. S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison-Wesley, California, 1988.
5. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub. /Pitman, New Delhi/London, 1987/1978.
6. K. Melhorn: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin, 1984.
7. D. E. Knuth: The Art of Computer Programming, Vol. 1, 2nd ed., Narosa/Addison-Wesley, New Delhi/London, 1973; Vol. 2: 2nd ed., Addison-Wesley, London, 1981; Vol. 3: Addison-Wesley, London, 1973.

Course Name: Advanced Database Management System

Course Code: MSCCS103

Module I: Normalization: Functional Dependencies and Normalization. [4L]

Module II: Query Processing and Optimization: Query processing and optimization: Steps of query processing, query interpretation, equivalence of expression, estimation of cost, join strategies [4L]

Module III: Transaction Processing and Concurrency Control: Transaction & Schedule, ACID property, Serializability, Anomalies with Interleaved execution, Conflict & 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]

Module IV: Distributed Database: Distributed Database System, Distributed Database Design, Data Fragmentation, Data Replication, Data Allocation, Query Processing in Distributed Databases. [10L]

Module V: Data Warehousing and Data Mining: Data Modelling for Data Warehouses, Concept Hierarchy, OLAP and OLTP. [4L]

Module VI: Big Data Systems: Big Data Characteristics, Types of Big Data, Big Data Architecture, Introduction to Map-Reduce and Hadoop; Distributed File System, HDFS. [5L]

Module VII: NoSQL and Query Optimization; Different NoSQL Products, Querying and Managing NoSQL; Indexing and Ordering Data Sets; NoSQL in Cloud. [5L]

Books and References:

1. Elmasri,Navathe,Fundamentals of Database System,3/e,Pearson Education.
2. Korth, Silberschatz : Database System Concepts, McGrawHill .
3. Ozsu,Principals of Distributed Database System,Pearson Education.
4. Ceri and Pelagatti, Distributed Databases: Principles and System: McGrawHill
5. T.J.Teorey - Database Modeling & Design, 3rd edition, Harcourt Asia Pte. Ltd., New Delhi, 2002.
6. Thomas Connolly, Carolyn Begg, “Database Systems”, Pearson Education, (2005)
7. Pramod J Sadalage and Martin Fowler, “NoSQL Distilled”, Pearson, (2012)

Course Name: Theory of Computation and Compiler Design

Course Code: MSCCS104

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, [4L]

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. [5L]

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. [5L]

Module IV: Syntax Analysis: Associativity, Precedence, Grammar Transformations, Top Down Parsing, Recursive Descent Predictive Parsing, LL(1) Parsing, Bottom up Parsing, LR Parser, LALR(1) Parser. [6L]

Module V: Semantic Analysis: Attribute Grammar, Syntax Directed Definitions, Inherited and Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L-attributed Definitions; Type-Checking. [5L]

Module VI: Run Time System: Storage Organization, Activation Tree, Activation Record, Stack Allocation of Activation Records, Parameter Passing Mechanisms, Symbol Table. [5L]

Module VII: Intermediate Code Generation: Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls. [5L]

Module VIII: Code Generation and Code Optimization: Control-flow, Data-flow Analysis, Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization, Instruction Scheduling. [5L]

Books and References:

1. John E. Hopcroft, Rajeev Motwani and Jeffery D. Ullman, Automata Theory,
2. Languages, and Computation (3rd. Edition), Pearson Education, 2008.
3. Michael Sipser, Introduction to the Theory of Computation, Books/Cole Thomson Learning, 2001.
4. JE Hopcroft and JD Ullman, Introduction to Automata Theory, Languages, and Computation, Addison-Wesley, 1979.

5. Aho, Sethi, Ullman – "Compiler Principles, Techniques and Tools" - Pearson Publication.
6. Compiler Design in C: Holub, PHI. 3)
7. Compiler Design: Dhamdhere

Course Name: Introduction to Environmental Science
Course Code: EVS-CB11

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.

Unit -2:

Ecosystems and Ecology Ecosystems: types, structures and function. Energy flow in ecosystem, Biogeochemical cycle, Population and Community ecology, Niche and Habitat concept, Succession, Biodiversity and Conservation Biology.

Unit-3:

Energy and Environment Energy Environment and Society, Renewable and Non-renewable energy resources, Types of Alternative energy, Energy security and Energy Audit.

Unit -4:

Green Technology

Applications of Green Technology, Green infrastructure, Green Chemistry, Green planning and economy.

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

Course Name: Data Structures and Algorithms Lab

Course Code: MSCCS105

Sample programs

1. i. Implement Insertion Sort (The program should report the number of comparisons) ii. Implement Merge Sort(The program should report the number of comparisons)
2. Implement Heap Sort(The program should report the number of comparisons)
3. Implement Randomized Quick sort (The program should report the number of comparisons) 4. Implement Radix Sort
5. Create a Red-Black Tree and perform following operations on it: i. Insert a node ii. Delete a node iii. Search for a number & also report the color of the node containing this number.
6. Write a program to determine the LCS of two given sequences
7. Implement Breadth-First Search in a graph.
8. Implement Depth-First Search in a graph.
9. Write a program to determine the minimum spanning tree of a graph

Course Name: Advanced Database Management System Lab

Course Code: MSCCS106

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.

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 .

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.

Module IV: PL/SQL.

Semester – II

Course Name: Artificial Intelligence & Soft Computing

Course Code: MSCCS201

Module I: Introduction: Definition, Goal, Importance, History, Applications, Components and Branches of Artificial Intelligence (AI) Turing Test. [3L]

Module II: Agents and Environments: Introduction, Concept of Rationality, Types of Agents, Types and Properties of Environments. [2L]

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 and Bound), Adversarial Search, Game Playing, Min-Max Search, Alpha Beta Cutoff Procedures. [6L]

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. [9]

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]

Module VI: Genetic Algorithms (GA): Encoding Strategies, Genetic Operators, Fitness Functions and GA Cycle; Problem Solving using GA. [6L]

Module VII: Artificial Neural Networks (ANN): Supervised, Unsupervised and Reinforcement Learning; Single Perceptron, Multi Layer Perceptron, Self Organizing Maps, Hopfield Network. [6L]

Books and References:

1. Artificial Intelligence – Making a System Intelligent by Dr. Nilakshi Jain, Wiley
2. Introduction to Artificial Intelligence & Expert System by D.W. Patterson, PHI
3. Introduction to Artificial Intelligence by Rich & Knight.
4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.

5. Genetic Algorithms: Search and Optimization, E. Goldberg.
6. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI

Course Name: Advanced Computer Networks

Course Code: MSCCS202

Module I: Data Communication: Components of a Data Communication System, Simplex, Half Duplex and Duplex Modes of Communication; Analog and Digital Signals; Noiseless and Noisy Channels; Bandwidth, Throughput and Latency; Digital and Analog Transmission; Data Encoding and Modulation Techniques; Broadband and Baseband Transmission; Multiplexing, Transmission Media, Transmission Errors, Error Handling Mechanisms. [5L]

Module II: Network Models: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses; Switching Techniques. [4L]

Module III: Functions of OSI and TCP/IP Layers: Framing, Error Detection and Correction; Flow and Error Control; Sliding Window Protocol, HDLC, Multiple Access – CSMA/CD, CSMA/CA, Reservation, Polling, Token Passing, FDMA, CDMA, TDMA, Network Devices, Backbone Networks, Virtual LANs. IPv4 Structure and Address Space; Classful and Classless Addressing; Datagram, Fragmentation and Checksum; IPv6 Packet Format, Mapping Logical to Physical Address (ARP), Direct and Indirect Network Layer Delivery; Routing Algorithms, TCP, UDP and SCTP Protocols; Flow Control, Error Control and Congestion Control in TCP and SCTP. [8L]

Module IV: Internetworking: Switch/Hub, Bridge, Router, Gateways, concatenated virtual circuits, Tunnelling, Fragmentation. [3L]

Module V: World Wide Web (WWW): Uniform Resource Locator (URL), Domain Name Service (DNS), Resolution - Mapping Names to Addresses and Addresses to Names; Electronic Mail Architecture, SMTP, POP and IMAP; TELNET and FTP. [5L]

Module VI: Mobile Technology: GSM and CDMA; Services and Architecture of GSM and Mobile Computing; Middleware and Gateway for Mobile Computing; Mobile IP and Mobile Communication Protocol; Communication Satellites, Wireless Networks and Topologies; Cellular Topology, Mobile Adhoc Networks, Wireless Transmission and Wireless LANs; Wireless Geolocation Systems, GPRS and SMS. [10L]

Module-VII: Cloud Computing and IoT: SaaS, PaaS, IaaS, Public and Private Cloud; Virtualization, Virtual Server, Cloud Storage, Database Storage, Resource Management, Service Level Agreement, Basics of IoT. [5L]

Books and References:

1. Data and Computer Communication, William Stallings. Prentice Hall of India.

2. Computer Networks — Andrew S Tanenbaum, 4th Edition. Pearson Education/PHI
3. Data Communications and Networking – Behrouz A. Forouzan, Third Edition TMH.
4. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education
5. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson COMPUTE
6. Internetworking with TCP/IP, Douglas Comer, Prentice Hall of India.
7. Ad Hoc Wireless Networks, Murthy and Manoj, Pearson.

Course Name: Advanced Operating System

Course Code: MSCCS203

Module I: Basics of Operating Systems: Operating System Structure, Operations and Services; System Calls, Operating-System Design and Implementation; System Boot. [2L]

Module II: Threads and CPU Scheduling: Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues, Scheduling Criteria and Algorithms; Thread Scheduling, Multiple Processor Scheduling [6L]

Module III: Deadlocks: Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Avoidance and Detection; Recovery from Deadlock. [4L]

Module IV: Process Management: Process Scheduling and Operations; Inter process Communication, Communication in Client–Server Systems, Process Synchronization, Critical-Section Problem, Peterson's Solution, Semaphores, Synchronization. [4L]

Module V: Memory Management: Contiguous Memory Allocation, Swapping, Paging, Segmentation, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files. Storage Management: Mass-Storage Structure, Disk Structure, Scheduling and Management, RAID Structure. [4L]

Module VI: Distributed operating system: Introduction of Distributed Systems, goals, transparency, services, Distributed System Architectures, communication network Architectures, issues in distributed operating systems, communication networks, communication primitives, and inherent limitations of a distributed system. [6L]

Module VII: Distributed Mutual exclusion: Clock synchronization, algorithms. Logical clock, physical clock, Election algorithms. Distributed transaction. Concurrency control. Distributed Deadlock: Detection and prevention. Algorithms. [8L]

Module VIII: Real Time Operating Systems: Real-time and non-real time applications. Classification of Real-Time Task scheduling algorithms, Event-driven scheduler- Simple priority-based, Rate Monotonic Analysis, Earliest Deadline First. [6L]

Books and References:

1. Mukesh Singhal, Niranjan Shivaratri: Advanced Concepts in Operating Systems, Tata McGraw-Hill Education, 2001.

2. A. S. Tanenbaum: Distributed Operating Systems, Prentice Hall of India, New Delhi, 1996.
3. Abraham Silberschatz , Peter B. Galvin , Greg Gagne :Operating System concepts 8th Edition, John Wiley & Sons.
4. S. J. Mullender (Ed.): Distributed Systems: An Advanced Course, 2nd ed., Addison-Wesley, Reading, Mass., 1993.
5. P. K. Sinha: Distributed Operating Systems, IEEE Press, Los Alamos, California, 1997.

Course Name: Discrete Structures and Optimization

Course Code: MSCCS204

Module I: Mathematical Logic: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference. [4L]

Module II: Sets and Relations: Set Operations, Representation and Properties of Relations, Equivalence Relations, Partially Ordering. [4L]

Module III: Counting, Mathematical Induction and Discrete Probability: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion- Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem. [5L]

Module IV: Group Theory: Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Integral Domains, Fields, Applications of Group Theory. [5L]

Module V: Graph Theory: Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Circuits, Planner graph, Graph Colouring, Bipartite Graphs, Trees and Rooted Trees, Prefix Codes, Tree Traversals, Spanning Trees and Cut-Sets. [8L]

Module VI: 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, Resource Levelling, Cost Consideration in Project Scheduling. [14L]

Books and References:

1. 1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Application to computer science [Tata McGraw –Hill]
2. Bernard Kolman c,Busby & Sharon Ross, Discrete Mathematical Structures
3. N. L. Biggs: Discrete Mathematics, Oxford Science Publications. 4.

4. W. Feller, W: An Introduction to Probability Theory and its Applications, Vol.1, John Wiley.
5. G. R. Grimmett and D. R. Stirzaker: Probability and Random Processes, Oxford Science Publications.
6. J. Nesetril, J. Matousek: Invitation to Discrete Mathematics, Clarendon Press.
7. Grassmann, Logic and Discrete Mathematics: A Computer Science Perspective, Pearson Education, 2007

Course Name: Environmental Management
Course Code: EVS – CB21

Unit 1: Natural Resource Management and Sustainability

Concept of natural resources; Water resources; Mineral resources; Energy resources; Land resources; Forest resources; Bio-resources and management; Sustainable use of resources.

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.

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.

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.

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.

Course Name: Advanced Operating System Lab

Course Code: MSCCS205

Unix/Linux commands, shell programming, system calls; demonstration of process / thread synchronization by writing codes (C / C++ / Java), simulation of CPU scheduling, page replacement, disk scheduling algorithms.

Course Name: Advanced Computer Networking Lab

Course Code: MSCCS206

Soket Programming.

Semester – III

Course Name: – Image Processing

Course Code: MSCCS301

Module I: Introduction: Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display. [4L]

Module II: Digital Image Formation: A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform. [4L]

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]

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]

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]

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
2. Fundamentals of Digital Image Processing; by Anil K Jain; PHI Publication
3. Arthur Weeks, Fundamentals of Electronic Image Processing, PHI

Course Name: Cryptography and Network Security

Course Code: MSCCS302

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]

Module II: Symmetric block ciphers, DES, Gallois field, polynomial arithmetic, AES, Principles of S Box design, Block cipher design principles, Other Block ciphers. [4L]

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]

Module IV: Secure hash functions, Understanding Collisions, Secure Hash Algorithms-SHA, HMAC, key management, Digital Certificates. [8L]

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. Cryptography and Network Security, Sixth Edition, Wiliam Stallings, Pearson.
2. Cryptography and Network Security, Special Indian Edition, B.A. Forouzan,TMH publishing Company Limited.
3. Cryptography and Network Security, Atul Kahate, Tata McGraw Hill Publication.
4. Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Edition, Bruce Schneier, Willy Publication.
5. Kaufman, Network Security: Private Communication in a Public World, Pearson Education.

Course Name: Advanced Software Engineering

Course Code: MSCCS303

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]

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]

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]

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]

Module V: Software Configuration Management: Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering. [4L]

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]

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]

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
2. Somerville, Software Engineering, Pearson Education
3. Jalote, Software Engineering, Narossa Publication
4. Robert C. Martin ,Agile Software Development, Principles, Patterns, and Practices
5. Succeeding with Agile : Software Development Using Scrum, Pearson (2010)

Course Name: Machine Learning

Course Code: MSCCS304

Module I: Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. [4L]

Module II: Supervised learning (Classification): Concept of supervised learning, Logistic Regression, Multivariate Regression Analysis, Support Vector Machine, Kernel function and Kernel SVM. [10L]

Module III: Instance based learning, Feature reduction, Collaborative filtering-based recommendation Probability and Bayes learning. [6L]

Module IV: Unsupervised learning (Clustering): Concept of unsupervised learning, k-means, adaptive hierarchical clustering. [6L]

Module V: Neural network: Perceptron, multilayer network, backpropagation. [8L]

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.
2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin
3. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson.
4. Machine Learning and Knowledge Discovery edited by Walter Daelemans, Katharina Morik
5. Pattern Recognition and Machine Learning by Christopher Bishop
6. Introduction to Machine learning with python by Andreas C. Müller and Sarah Guido
7. Deep Learning, Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra, Pearson.

Course Name: Machine Learning Lab

Course Code: MSCCS305

1. Exercises to solve the real-world problems using the following machine learning methods:

- Linear Regression
- Logistic Regression
- Multi-Class Classification
- Neural Networks •

Support Vector Machines •

K-Means Clustering & PCA

2. Develop programs to implement Anomaly Detection & Recommendation Systems.

Course Name: Minor project

Course Code: MSCCS306

A rea life minor project: problem on current topics in the field of Computer Science and / or Information Technology involving reasonable size program development (which is not possible in practical classes) will be assigned to every student and the student has to present the problem in form of seminar (at the end of 3rd semester) in presence of departmental teacher(s) and external expert(s). Student will carry on his / her project work in guidance of one departmental teacher.

Semester - IV

Course Name: Green Computing

Course Code: MSCCS401

Logistics, Introduction to Green Computing & Background, Energy Management in Embedded Systems and Sensor Networks, Energy Management in Mobile Systems and Smartphones, Greening Desktop and Laptop PCs, Energy Efficient Networking and Communication, Greening Data Centers and Servers, IT Enabled Smart Buildings, Sensing within Buildings (Occupancy), Sensing within Buildings (Energy and Water), Managing the Data Deluge and ―App Platforms‖ for Smart Buildings, Energy Management in Smart Homes, Modeling, Prediction and Control for Smart Buildings, Security and Privacy. [40L]

Text Books: 1.

1. The Green Computing Book: Tackling Energy Efficiency at Large Scale by Wu Chun Feng
2. Green Computing: Tools and Techniques for Saving Energy, Money, and Resources by Bud E. Smith

Course Name: Electives E1

Course Code: MSCCS402

A: Cloud Computing

B: Internet of Things

C: VLSI Design

Course Name: A: Cloud Computing

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. [5L]

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. [10L]

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]

Module-IV: Cloud Platforms and Applications: Overview on Amazon Web Services, Google App Engine and Microsoft Azure, Cloud applications in scientific, business and consumer Domain. [8L]

Module-V: Cloud Simulators- CloudSim and GreenCloud Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud. [8L]

Module-VI: Cloud Security: Tools and technologies to secure the data in Private and Public Cloud Architecture. Security Concerns, Legal issues and Aspects, Multi-tenancy issues. [5L]

Books and References:

1. Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010
2. Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online - Michael Miller - Que 2008
3. Judith Hurwitz, R Bloor, M.Kanfman, F.Halper "Cloud Computing for Dummies", Wiley India Edition, First Edition
4. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley Publication,2011

Course Name: B: Internet of Things

Module I: IoT: Concept of IOT, Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues. [4L]

Module II: IoT protocol: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security. [10L]

Module III: IoT architecture: IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity : An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction. [8L]

Module IV: Web of things: Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. [8L]

Module V: IoT applications and Challenges: IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of

existing IoT platforms /middleware, IoT- A, Hydra etc., Big Data Management, Connectivity challenges, Mission critical applications. [10L]

Books and References:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet ofThings", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a HighlyConnected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applicationsand Protocols", Wiley, 2012. References:
5. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
6. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013

Course Name: C: VLSI Design

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]

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]

Module III: VLSI Design Process: System Specification, Functional Design, Logic Design, Circuit Design, Physical Design, Verification, Fabrication and Packaging. [5L]

Module IV: Design Styles: Custom Design, Standard-Cell Design, Gate-Array Design, FPGA, and MCMs. [5L]

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).
2. Basic VLSI Design. D. A. Pucknell and K. Eshraghian. Pearson College Div., Subsequent edition (January 1, 1995).

3. An Introduction to VLSI Physical Design. M. Sarrafzadeh and C. K. Wong. McGraw-Hill College (February 21, 1996).
4. Algorithms for VLSI Physical Design Automation. N. A. Sherwani. Springer; 3rd edition (November 30, 1998).
5. Multi-Layer Channel Routing: Complexity and Algorithms. R. K. Pal. Narosa, 1st edition (September 28, 2000).

Course Name: Electives E2

Course Code: MSCCS403

A: Natural Language Processing

B: Deep Learning

C: Computer Vision

Course Name: A: Natural Language Processing

Module I:

Regular Expressions and Automata Recap Introduction to NLP, Regular Expression, Finite State Automata. [2L]

Tokenization: Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance. [4L]

Morphology: Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer. [4L]

Module II

Language Modelling: Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models. [4L]

Hidden Markov Models and POS Tagging: Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging – Rule based and Machine Learning based approaches, Evaluation. [4L]

Module III

Text Classification: Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis – Opinion Mining and Emotion Analysis, Resources and Techniques . [5L]

Context Free: Grammar Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing. [5L]

Module IV

Computational Lexical Semantics: Introduction to Lexical Semantics – Homonymy, Polysemy, Synonymy, Thesaurus – WordNet, Computational Lexical Semantics – Thesaurus based and Distributional Word Similarity. [6L]

Information Retrieval: Boolean Retrieval, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback. [6L]

Books and References:

1. Speech and Language Processing, Jurafsky and Martin, Pearson Education
2. Foundation of Statistical Natural Language Processing, Manning and Schutze, MIT Press
3. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
4. Allen J., Natural Language understanding, Benjamin/Cunnings, (1987).
5. Jensen K., Heidorn G.E., Richardson S.D., Natural Language Processing: The PLNLP Approach, Springer (2013).

Course Name: B: Deep Learning

Module I

Introduction: Introduction: Various paradigms of earning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques. [3L]

Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Softmax. [2L]

Module II

Artificial Neural Networks: Introduction, Perceptron Training Rule. Gradient Descent, Stochastic Gradient Descent, Backpropagation, Some problems in ANN. [4L]

Module III

Optimization and Regularization: Overfitting and Capacity, Cross Validation, Feature Selection, Regularization, Hyperparameters. [4L]

Module IV

Convolution Neural Networks: Introduction to convolution neural networks: stacking, striding and pooling, CNN applications. [8L]

Module V

Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications. [6L]

Module VI

Generative models: Restrictive Boltzmann Machines (RBMs), Stacking RBMs, Belief nets, Learning sigmoid belief nets, Deep belief nets, Autoencoders. [7L]

Deep Learning Tools: Caffe, Theano, Torch. [6L]

Books and References:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
3. Deep Learning, Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra, Pearson.
4. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
5. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
6. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Course Name: C: Computer Vision

Module I:

Introduction: Image Processing, Computer Vision and Computer Graphics, what is Computer Vision - Low-level, Mid-level, High-level, Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality. [6L]

Module II:

Image Formation Models: Monocular imaging system, Radiosity: The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, colour etc, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images. [6L]

Image Processing and Feature Extraction: Image pre-processing, Image representations (continuous and discrete), Edge detection. [4L]

Module III:

Motion Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion. [4L]

Shape Representation and Segmentation: Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, and Multiresolution analysis. [6L]

Module IV:

Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component analysis, Shape priors for recognition Image Understanding: Pattern recognition methods, HMM, GMM and EM. [6L]

Module V:

Applications: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis. [5L]

Application in-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians. [3L]

Books and References:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall. 3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.
3. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.
4. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
5. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson. 7. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012
6. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
7. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

Course Name: Major Project Work

Course Code: MSCCS404

Project Work: Students should complete their project work preferably in the department under the guidance of a teacher of the department. After getting necessary permission from the department students may opt for internship from a reputed institution or industry under the supervision of the departmental teacher (Act as a co guide). Duration of the project will be entire semester. After completion of the project work, student should prepare a report and present a seminar in front of departmental teachers as well as external expert(s).