THE UNIVERSITY OF BURDWAN

DEPARTMENT OF COMPUTER SCIENCE

SYLLABUS FOR M. Sc. (COMPUTER SCIENCE) COURSE (2024-2025)

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1) Duration : Two Years (Four Semesters)

2) Total Marks : 1250 (300 + 300 + 300 +350)

3) Total Credit Points : 92 (22 + 22 + 22 + 26)

4) Number of Papers : Total Twenty Five, out of which, fourteen are Theoretical, eight Practical, One Term Paper, One Project Work and One Social Outreach Programme.

5) Distribution of Marks : All Theoretical and Practical papers are of full marks 50, out of which, 40 marks for University Exam. & 10 marks for Sessional. Sessional marks of theoretical papers will come from two mid – term examinations of 10 marks each. For Term Paper 50 marks will be of University Exam. For Project Work paper full marks is 100, out of which 80 for University Exam and 20 for Sessional marks. Marks for social outreach program will be 25 out of 20 for University exam and 5 for sessional examination.

6) Duration of Univ. Exam : Two Hours for Theoretical Papers and three Hours for Practical Papers.

7) Instruction Period : In L-T-P pattern, 'L' lectures, 'T' tutorials, and, '2xP' practical hours per week are needed for each paper. Unless otherwise specified, credit point of a paper will be: L + T + P. At least 50 hours are needed for each theory and practical paper. Two hours per week will be given for remedial purpose.

8) Semester Duration : 16 Weeks (approx.).

Program Outcome

The new curriculum of the two-year postgraduate program of Computer Science aims to develop the core competence in computing and problem solving amongst its graduates. Informally, “Learning to learn” has been the motto of the department since its inception. The curriculum thus focuses on building theoretical foundations in computer science to enable its pupils to think critically when challenged with totally different and new problems. It imbibes the following Student-Centric features.

Employability: Industry demand in the IT sector has changed considerably in the past few years. With the humongous amount of data coming from all the domains like medical data, social networking data, astronomical data, education, etc., automating information extraction and analysis of data is the only way forward to leverage the available data for the future. This curriculum aims to equip the students with tools and techniques of Artificial Intelligence, Machine Learning and a pathway on Data Science if the student so desires. Having said this, there is no replacement for the foundational courses like programming, data structures and algorithms. With two courses on programming and two courses on data structures and algorithms together, a strong foundation will be laid down for problem solving.

Research: With the option to obtain specialization in an area of the curriculum prepares the students to take up term paper (literature review) and research projects in their career.

M.Sc. (Computer Science) 2024-2025 Batch

Semester – I

Courses	(L-T-P)	Credits
MSCS- 101: Advanced Algorithm Design	(3-1-0)	4
MSCS -102: Advanced Computer Architecture	(3-1-0)	4
MSCS -103: Advanced Software Engineering	(3-1-0)	4
MSCS -104: Numerical & Statistical Computing	(3-1-0)	4
MSCS –105: Lab I (Advanced Algorithm Design)	(0-0-3)	3
MSCS -106: Lab II (Advanced Software Engineering and Numerical & Statistical Computing)	(0-0-3)	3
Semester Credits	**22**	

Semester – II

Courses	(L-T-P)	Credits
MSCS- 201: Advanced Operating Systems	(3-1-0)	4
MSCS- 202: Advanced Computer Networks	(3-1-0)	4
MSCS-203: AI & Applications	(3-1-0)	4
MSCS- 204: Advanced DBMS	(3-1-0)	4
MSCS- 205: Lab III (Advanced Operating Systems and Advanced Computer Networks)	(0-0-3)	3
MSCS-206: Lab IV (AI & Applications and Advanced DBMS)	(0-0-3)	3
Semester Credits	**22**	

Semester – III

Courses	(L-T-P)	Credits
MSCS-301: Compiler Design	(3-1-0)	4
MSCS-302: Discipline-centric Elective (E1)	(3-1-0)	4
MSCS-303: Term Paper: Minor Project	(0-2-2)	4
MSCS -304: Generic Elective (GE) Or MSWM-304	(2-0-0)	2
MSCS-305: Lab V (Compiler Design)	(0-0-3)	3
MSCS-306: Lab VI (Discipline-centric Elective : E1)	(0-0-3)	3
MSCS-307: Community Engagement Activities	(0-0-2)	2
Semester Credits	**22**	

MSCS-302-Discipline-centric Elective (E1)

A: Machine Learning
B: Cryptography and Network Security
C: Software Project Management
D: Data Mining
E: Object Technology using JAVA
F: Soft Computing
G: Block Chain Technology
H: May be opted from SWAYAM

MSCS-304-Generic Elective

A: Internet and E-Commerce
B: Web Security
C: Introduction to Artificial Intelligence
D: Cryptography
E: Introduction to Programming
Or
F: MSWM-304 - May be opted from SWAYAM

Semester – IV

Courses	(L-T-P)	Credits
MSCS-401: Discipline-centric Elective (E2)	(3-1-0)	4
MSCS-402: Discipline-centric Elective (E3)	(3-1-0)	4
MSCS-403: Major Project	(0-4-4)	8
MSCS-404: Seminar and Grand Viva	(0-2-2)	4
MSCS-405: DE Lab VII(E2)	(0-0-3)	3
MSCS-406: DE Lab VIII(E3)	(0-0-3)	3
Semester Credits	**26**	
Cumulative Credits	**92**	

Discipline-centric Elective (E2)
A: Operation Research and Optimization
B: Model Checking
C: Bioinformatics
D: Internet of Things
E: Web Technology
F: Deep Learning and NLP

Discipline-centric Elective (E3)
A: Mobile Computing
B: Computer Graphics & Multimedia
C: Real time system
D: Image Processing
E: Theory of Computing
F: Data Science

MSCS-101: Advanced Algorithm Design

UNIT-I: Introduction to Advanced Data Structures:Introduction to Data Structures, Linear Data Structures, Binary Trees, insertion and deletion in BST. Query in BST, Thread Binary Trees, Balancing Trees, AVL Trees, Red black Trees, B Tree, Splay Trees, Heap, different data structures for heap, double ended heap, Priority Queue, Data Structure for Disjoint-Sets. K-D Tree, removal of recursion. Introduction to Object Oriented Data Structures. [20%]

Unit-II: Analysis of Algorithm: Solving problem using computer, general problem solving approach – STAIR, reduction to known problem, meaning of algorithm, steps in development of algorithm, evolution of algorithms, design by analysis, design by synthesis, algorithm design patterns and frameworks, Correctness of an algorithm; concept of space and time complexity; asymptotic analysis, amortization, randomization and experimental analysis; best, worst and average case, order of growth, asymptotic notations, upper and lower bounds; analysing rate of growth of a function with that of known functions, comparing algorithms w. r. t. order of growth; applying algorithm analysis concepts for complexity analysis of different sorting techniques. [10%]

UNIT-III: Divide and Conquer: Introduction to top – down approach, divide – and – conquer approach, identifying problems where divide – and – conquer suits / is unsuitable, analysis of divide and conquer algorithms, recurrences, the master method for solving recurrences. [10%]

UNIT-IV: Dynamic Programming : Principle of optimality, bottom – up approach to problem solving, comparison with top – down approach, application of dynamic programming to solve problems using optimal sequence of decisions, comparison with brute – force method for finding optimal solution, possibility of multiple sequences in dynamic programming, overlapping sub – problems and optimal substructures, avoiding further exploration of sub – optimal decisions using memoizations, examples of problems; correctness of dynamic programming; analysis of dynamic programming. [10%]

UNIT-V: Greedy Algorithms: Another approach to find optimal solution by generating only one decision sequence (locally best choice when all available choices are exhausted), optimal substructure and greedy choice; greedy algorithms vs. dynamic programming; examples of problems; analysis of greedy algorithm; matroids; correctness of the greedy algorithm on matroids. [10%]

UNIT-VI: Graph algorithms: Introduction to graphs and their representations, Graph traversal, DFS, BFS and applications, Connectivity, strong connectivity, bi-connectivity, Minimum spanning tree, Shortest paths, all pair shortest path, Matching, Network flow. [20%]

UNIT-VI: String Algorithms: Naive string matching, Rabon-Karp, Matching with FA, KMP algorithm, Boyer-Moore algorithm, LCS, String compression algorithms, Introduction to DNA, RNA sequence and base pair, Sequence alignment, local and global sequence alignment, eit distance, Levenshtein distance,

Needleman–Wunsch algorithm, Smith-Waterman algorithm, Hirschberg's algorithm, gap and gap penalty. [20%]

REFERENCE BOOKS:

1.*Introduction to Algorithms – A Creative Approach*: Udi Manber, Addison – Wesley Professional

2.*Introduction to Algorithms:* Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, MIT

3.*Algorithms:* Richard Johnsonbaugh, Marcus Schaefer, Pearson

4.*Fundamentals of Computer Algorithms:* Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, University Press

5.*Design and Analysis of Algorithms:* Parag Himanshu Dave, Himanshu Bhalchandra Dave, Pearson

6.*Algorithm Design:* Jon Kleinberg, Éva Tardos, Pearson Education

7.*Randomized Algorithms*: Rajeev Motwani, Prabhakar Raghavan, Cambridge University Press

8.*Analysis of Algorithms: Computational Methods & Mathematical Tools:* Micha Hofri, Oxford University Press, USA

9.*Parallel Computers Architecture and Programming: V. Rajaraman, C. Shiv Ram Murthy, PHI*

10.*Parallel Programming in C with MPI and OpenMP: Michael J. Quinn, Tata McGraw Hill*

Course Outcomes:

After undergoing the course, Students will be able to understand:

- Students should develop a sound theoretical understanding of advanced algorithms and practical problem solving skills using them.
- Students should develop basic knowledge of a wide range of advanced algorithm design techniques including dynamic programming, linear programming, approximation algorithms, and randomized algorithms.
- Students should develop basic advanced algorithm analysis skills for analyzing the approximation ratio of approximation algorithms and the probability of randomized algorithms.
- Students should gain a good understanding on a wide range of advanced algorithmic problems, their relations and variants, and application to real-world problems.

MSCS-102: Advanced Computer Architecture

Unit I: Evolution of Computer Systems, Basic Operations of Computer, Moore's Law, Introduction to Software and Hardware Systems, Instruction set architecture, Amdahl's law, Processor activities, Data Path architecture and controller. [20%]

Unit II: State machine design. Control unit design: Micro programmed and hardwired. Instruction format and addressing Modes. Micro instructions. Design of Adder, Multiplier, and Divider. Floating point numbers and arithmetic. [25%]

Unit III: Introduction to memory system, CPU memory interaction, Cache organization, RISC vs. CISC, Memory Hierarchy, Virtual Memory. [25%]

Unit IV: Programmed I/O, Interrupt driven I/O, I/O devices, Direct Memory Access, Bus organization, Secondary storage. [10%]

Unit V: Concepts of Pipelining, pipeline scheduling, Arithmetic pipeline, Instruction set Pipelining, dynamic pipelining, and arithmetic pipelines, Vector Processing Principles- Instruction types, Compound, Vector Loops, and Chaining. Array Processors- Structure: Systolic array, Algorithms, Parallel Processing Architectures. [20%]

Reference Books:

1) *Digital Logic and Computer Design: M. M. Mano, PHI.*

2) Digital Logic Design Principles: Bradley Carlson, Norman Balabanian, Wiley India.

3) Structured Computer Organization: A. S. Tanenbaum, PHI.

4) Computer System Architecture: M. M. Mano, PHI.

5) Digital Logic Design: Holdsworth, Elsevier India.

6) Digital Logic Design: Guy Even, Moti Medina, Cambridge University Press .

7) Digital Design Principles and Practices: John F. Wakerly, Pearson Education.

8) Fundamentals of Digital Logic with VHDL Design: Stephen Brown, Zvonko Vranesic, Tata McGraw Hill.

Course Outcomes:

After undergoing the course, Students will be able to understand:

- Understand the evolution of computer systems, basic computer operations, and fundamental performance laws like Moore's and Amdahl's.
- Design and analyze control units, instruction formats, arithmetic units, and apply microprogramming concepts.
- Understand I/O systems including programmed I/O, interrupt-driven I/O, DMA, bus architectures, Pipelines

MSCS – 103: Advanced Software Engineering

Unit I: Software characteristics, components & applications, software engineering - a layered technology, Software Process. Introduction to software engineering models, linear sequential waterfall model, prototype & RAD model, evolutionary software process model, incremental model and spiral model. Basics of software project management, project management

concepts, people, problem & process.Notion of project metrics, metrics in the process & project domains, software measurement, size oriented, function oriented metrics, extended

function. [20%]

Unit II: Idea of software project planning, scope of planning, project estimation, project decomposition techniques, empirical estimation models. Introduction to software analysis, requirement analysis, communication techniques, analysis principles, software prototyping, specifications. Elements of the analysis modelling, data modelling, functional model ling & information flow, behavioral modelling, data dictionary. [20%]

Unit III: Design process, design concepts, design principles, effective modular design. Different design methods, architectural design process, transform mapping & transaction mapping, internal external design, human computer interface design, interface design guidelines, procedural design, object oriented design. [15%]

Unit IV: Introduction to software quality, quality concepts, metrics for software quality, quality movement, S/W Q A, S/W review, formal approaches to software quality assurance, S/W reliability, ISO standards. [10%]

Unit V: Fundamentals of software testing, test case design, white and black box testing, basic path testing, control structures.Strategic approach to software testing, unit testing, integration testing, validation testing, system testing, alpha testing, beta testing, debugging. [15%]

Unit VI: Software reusability, reuse process, building reusable components, classified & retrieving components, economics behind software reusability. [10%]

Unit VII: Introduction to computer aided software engineering (CASE),, building block for CASE, taxonomy of CASE tools, integrating CASE environment, integrating architecture, CASE repository. [10%]

Reference Books:

1) *R.S.Pressman, Software Engineering.*

2) *Pankaj Jalote, An Integrated Approach To Software Engineering.*

3) *Rajib Mall, Fundamentals of Software Engineering, PHI.*

Course Outcomes:

After undergoing the course, Students will be able to understand:

- The course is designed to analyze the system.
- Understand software characteristics, processes, engineering models, and project management fundamentals.
- Apply software planning, requirement analysis, and modelling techniques for effective system analysis.
- Design software systems using modular, architectural, and interface design principles.
- Evaluate software quality using assurance techniques, standards, and testing strategies.
- Explore software reusability and CASE tools for efficient and cost-effective software development.

MSCS – 104: Numerical and Statistical computing

Unit I: Numerical Computing:

Computer Arithmetic: Floating Point Numbers – Operations, Normalization and their consequences, Types of error.

Iterative Methods: Zeros of Transcendental Equations and Zeros of Polynomials using Bisection, Newton –Raphson , Regula falsi method, Successive approximation , secant method.

Convergence of solution.Solution of Simultaneous Linear Equations: Gauss Elimination Method and Pivoting, iii-Conditioned Equations and Refinement of Solutions, Gauss-Siedal Iterative Method.

Interpolation and approximation: Difference Table, Polynomial Interpolation, Newton, Lagrange etc, Piecewise Polynomial and Spline Interpolation; Approximation of Functions by Taylor Series And Chebyshev Polynomials.

Numerical Differentiation and Integration of Functions: classical formula for Equality Spaced Abscissa, Simpson's 1/3 Rule, Trapezoidal Rule with interval Halving Techniques, Romberg Integration, Gauss Quadrature, Monte-Carlo Method for Multidimensional Integrals.

Solution of Differential Equations: Ordinary first order differential equations. Difference equation, Single and Multistape Methods, Runge-Kutta Method, Predictor Corrector Methods, Automatic Error Monitoring, and Stability of Solutions.

[50%]

Unit II: Statistical Computing:

Graphical Representation of Statistical Data, Frequency Distribution, Measures of Central Tendency and Dispersion, Random variable and it's expectation and Variance. Probability models – Binomial, Poission and Normal.

Bivariate Frequency Distributions. Scatter Diagram, Product Moment, Correlation Coefficient and its properties (statements only) Regression Lines, Correlation Index and Correlation Ratio, Spearman Rank Correlation.

Multiple Linear Regression, Multiple Correlation, Partial Correlation (without Derivation).

Random Sampling (with replacement and without replacement), Expectations and Standard error of Sampling Mean (without Derivation). Expectation and standard error of Sampling Proportions.

Point of Estimation of Parameters. Maximum likelihood estimation, interval estimation of parameters, test of significance based on t, F, and CHI square distribution.

Arge sample tests, Tests based on Pearsonian Frequency CHI-square.

Classification of models: Principle component analysis, cluster analysis, support vector machine,decision tree analysis.

[50%]

Reference Books:

1) Numerical Recipes in C – The art of Scientific computing – William H. Pras et al. Cambridge Univ. Press, 1988 reprint.

2) C Language and Numerical Methods – C Xavier, New Age International.

3) Numerical Methods, Software and analysis – John R. Rice, McGrew Hill International Edn. 3rd Printing, 1987.

4) Computer Assisted Statistics – F. Scalzo

5) Fundamentals of Statistics – Goon, Gupta and Dasgupta

6) Statistical Programs in FORTRAN – Schwartz and Basso, Reston publ. co.

7) Numerical and Statistical method with programming in c --- Sujata Sinha, Subhabrata Dinda ,Scitech Publication.

Course Outcomes:

After undergoing the course, Students will be able to understand:

- Obtain an intuitive and working understanding of numerical methods for the basic problems of numerical analysis.
- Gain experience in the implementation of numerical methods using a computer.
- Trace error in these methods and need to analyze and predict it.
- Provide knowledge of various significant and fundamental concepts to inculcate in the students an adequate understanding of the application of Statistical Methods.
- Demonstrate the concepts of numerical methods used for different applications.

MSCS –105: Lab I (Advanced Algorithm Design)

Algorithm Lab: Implementations of algorithms related to MSCS-101 using C and C++.

Course Outcomes:

By the end of course through lab students will demonstrate:

- to apply knowledge of computing and mathematics to algorithm design.
- to analyze a problem and identify the computing requirements appropriate for its solution.
- An ability to apply design and development principles in the construction ofsoftware systems of varying complexity.
- Recognition of the need for and an ability to engage in continuing professional development.
- An ability to use current techniques, skills, and tools necessary for computing practice

MSCS -106: Lab II (Advanced Software Engineering and Numerical & Statistical Computing)

Software Lab: Simulating and testing different SE principles. Writing programs for solving Numerical and statistical algorithms.

Course Outcomes:

After completion of course student will be able to:

- Acquire the generic software development skill through various stages of software life cycle.
- Ensure the quality of software through software development with various protocol based environment. generate test cases for software testing.
- Apply the knowledge of Numerical methods in different programming language, solving linear equations problems in various branch of engineering.
- Apply the concept of and Data representation and analysis in various field of engineering like image processing etc.
- Apply concept of Correlation and Regression in result analysis and Business forecasting using EXCEL, MATLAB, etc.

MSCS- 201: Advanced Operating Systems

Unit I: OS services and components, multitasking, multiprogramming, time sharing, Process & thread management, CPU scheduling, context switching, multithreading Concurrency control, mutual exclusion requirements, semaphores, Dead locks - detection, recovery, avoidance and prevention. Inter process Communication: Remote Procedure Call overview and implementation. The client server model. [30%]

Unit II: Introduction to Memory management, architecture and hardware and microprocessor level support to memory management. Memory technology, cache memory, Partitioning,

swapping, paging, segmentation, virtual memory, Demand paging, page replacement and allocation algorithm. Memory hierarchy, cache memory management, Secondary-storage management, file system management. Case study of memory management in intel 8085, 8086, 80286, 80386. [20%]

Unit-III: Multi processor Systems: Introduction to multi processor systems, architecture of Multiprocessor systems, types of multi processor systems. structure of multi processor OS, UMA and NUMA and cc-NUMA architecture, process synchronization, process scheduling and migration, memory shar9ing, parallel multi processor programming, introduction to OpenMP. [20%]

Unit IV: Introduction of Distributed Systems, services, Distributed System Architectures, communication network Architectures, Distributed Mutual exclusion: Clock synchronization, algorithms. Logical clock, physical clock, Election algorithms. Distributed transaction. Concurrency control. Distributed Deadlock, Introduction of Distributed shared memory, Naming-Overview, Name caches, Naming and security, DNS. Introduction, Security issues in Distributed OS. Distributed computation using google go. [20%]

UNIT-V: Case studies: Case study of LINUX, commands, pipes, filters, Shell programming, Different types of shells, Bash , C shell, Introduction to Kernel programming, system calls for Low level IO, Memory management, process management, and IPC. [10%]

Reference Books:

1) *Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems -Mukesh Singhal, Niranjan G.Shivaratri- TMH, 2001.*

2) Modern operating system -Andrew S.Tanenbaum- PHI, 2003.

3) Distributed operating systems and algorithm analysis-Randy chow,Theodore Johnson-Pearson,2011.

4) Distributed operating system Concepts and design -Pradeep K.Sinha- PHI, 2003.

5) Distributed operating system -Andrew S.Tanenbaum- Pearson education, 2003.

6) Distributed Systems Concepts and Design -G Coulouris, J Dollimore and T Kindberg-Third Edition, Pearson Education.

Course Outcomes:

After undergoing the course, Students will be able to understand:

- General architecture of computers
- Understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files
- Understand and use advanced concepts in operating systems
- Understand the high-level structure of the Linux kernel both in concept
- At the end of the course, students are expected to be proficient in details of operating systems and be sensitive to implementation and performance tuning of operating systems in preparation to entering the industry or in pursuit of graduate studies.

MSCS-202: Advanced Computer Network

Unit I: Introduction: Communication Tasks, Communication Model, Network Architecture, ISO/OSI Reference Model, Switching, TCP/IP Model. [10%]

Unit II: Error Detection and Correction Techniques: One and Two Dimensional Parity Checks, CRC, Hamming code, Framing: Bit and Character Stuffing. [10%]

Unit III: Flow control: Delays in Point-to-Point links, Stop-and-Wait Flow Control, Effect of Propagation Delay and Transmission Rate on Performance, Sliding Window Protocol, and Error Control- ARQ: Stop and Wait, Go-back-N, Selective Reject etc. Transmission Efficiency of ARQ Protocols. HDLC protocol. [20%]

Unit IV: Data Link Control protocols: HDLC, Point-to-Point Protocol. MAC and LLC Sub layers: Channel Allocation Problem, Static and Dynamic Channel Allocation, Pure and Slotted ALOHA, Persistent and non-persistent CSMA, Collision Free Protocols: Bit-Map protocol, Binary Countdown, Limited Contention protocols, Adaptive Tree Walk protocols. [20%]

Unit V: IEEE 802 Standards for LAN and MANs: Ethernet, Token Bus, Token Ring, DQDB, FDDI, LAN Bridges: IEEE 802.x to IEEE 802.y Bridges, Transparent Bridge, Source Routing Bridge, Mixed Media Bridge etc. [10%]

Unit VI: Network Layer: Services, Packet Switching, Congestion Network Routing: Routing Characteristics, Routing Algorithms-Shortest Path algorithm: Dijkstra's Algorithm, Bellman-Ford Algorithm, Fixed Routing, Flooding, Random Routing, Adaptive Routing: Flow based Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast and Multicast Routing: Multi-destination routing, Spanning Tree Routing, Reverse Path Forwarding. Congestion: General principles. Congestion Prevention Policies, Traffic Shaping, LeakyBucket Algorithm, Token Bucket Algorithm. Network Layer Protocols: IPV4 Datagram Formats, IPV4 Packet Forwarding Unicast and Multicast Routers. [20%]

Unit VII: Transport layer Protocols. UDP, TCP: Services; TCP Flow Control, TCP Error control, TCP congestion control, TCP timers 6. (IT/T/226) Numerical Methods & Optimization Technique. [10%]

Reference Books:

1) Leon Garcia- Computer Network Communication – TMH.

2) Kirch – " Linux network Administrator'sguide (2nd Ed.)" – O'Rielly.

3) Maxwell – "Unix system administration" - TMH.

4) Limoncelli –"The Practice of System & Network Administration"-Pearson.

Course Outcomes:
After undergoing the course, Students will be able to understand:

- Independently understand basic computer network technology.
- Understand and explain Data Communications System and its components.
- Identify the different types of network topologies and protocols.
- Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
- Identify the different types of network devices and their functions within a network
- Understand and building the skills of subnetting and routing mechanisms.
- Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

MSCS-203: Artificial Intelligence & Applications

Unit I: Introduction: Importance of Artificial Intelligence (AI). [5%]

Unit II: Problem solving using AI approach: Water-jug problem, missionary carnival problem , 8-Puzzel problem, vacuum-cleaner problem, travelling-salesman problem, N-Queen problem,Wampus world problem. [10%]

Unit III: Knowledge: Its representation, Organisation, Manipulation and Acquisition. [5%]

Unit 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. [10%]

Unit V: AI Programming Languages: Introduction to PROLOG and LISP. [20%]

Unit VI: Production Systems and Search Strategies: Production System and its variants, Search Methods, Heuristic Search Methods , AND/OR Graphs and AO* Algorithm,Searching Game Trees. [10%]

Unit VII: Soft Computing and Uncertainty Management: Introduction to Fuzzy Logic, NN and GA; Bayesian inferencing, Dempster-Shafer theory of Beliefs. [10%]

Unit VIII: Structured Representation of Knowledge and reasoning: Semantic Networks, Frames, Scripts, and Conceptual Dependency. [8%]

Unit IX: Expert Systems(ES): Rule Based Expert System Architecture, Non-production System Architecture, Neural Network based ES, Knowledge Acquisition Methods, Explanation Methods, Case study: Mycin; Expert System Shells.

[12%]

Unit X: Introduction to Pattern Recognition, Natural Language Processing, Planning**,** etc.

[10%]

Reference Books:

1) Introduction to Artificial Intelligence & Expert System by D.W. Patterson, PHI.

2) Introduction to Artificial Intelligence by Rich & Knight.

3) Principle of Artificial Intelligence by N.J. Nilson, Narosa.

Course Outcomes:

After undergoing the course, Students will be able to :

- Understand the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.
- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.
- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
- Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

MSCS-204: Advanced DBMS

Unit I: ER Model: Review of ER constructs, Advanced ER constructs, Object Oriented Data Modelling.

[5%]

Unit II: ER Modelling in Logical Database Design: Introduction, Requirements analysis and ER Modelling, View Integration, Entity clustering. [10%]

Unit III: Normalization and DB design: Fundamentals of Normalization, Design of Normalised Tables, Normalization of Candidate Tables derived from ER diagram, Determining the minimum set of 3NF tables, Fourth & Fifth normal forms, Requirements specification, Logical Design, Physical Design. [15%]

Unit IV: Access Methods: Sequential Access Methods, Random Access Methods, Secondary-storage Indexes, Denormalization, Join Strategies. [10%]

Unit V: Transaction Processing and Concurrency Control: Review of basic concepts, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Transaction Support in SQL Concurrency Control Techniques, Two-Phase Locking Techniques for Concurrency Control, Concurrency Control Based on Timestamp Ordering, Multiversion Concurrency Control Techniques, Validation (Optimistic) Concurrency Control Techniques, Granularity of Data Items and Multiple Granularity Locking, Using Locks for Concurrency Control in Indexes, Other Concurrency Control Issues Recovery Concepts, Recovery Techniques Based on Deferred Update, Recovery Techniques Based on Immediate Update, Shadow Paging, The ARIES Recovery Algorithm, Recovery in Multidatabase Systems, Database Backup and Recovery from Catastrophic Failures. [20%]

Unit VI: Distributed Data Allocation: Introduction, Distributed & Multi database Design, General Data Allocation problem, Data allocation strategies. Query processing in distributed database. [15%]

Unit VII:Data Warehousing, OLAP and Data Mining: Overview of Data warehousing, Logical Design, Physical Design, OLAP, Data Mining. [10%]

Unit VIII: Advanced Database Technology: Architecture for advanced technology, Object-oriented & Object – Relational Database, Spatial and Geographic Databases, Multimedia Databases. [15%]

Reference Books:

1) A.Silberchatz et.al. – Database System Concepts 3rd Edn. McGraw Hill Inc., 1997.

2) R.Elmasri et.al. – Fundamentals of Database Systems, Addison Wesley, Indian Reprint,New Delhi, 2000.

3) R.Rama Krishnan – Database Management Systems, McGraw Hill International Edn., New York, 1998.

4) T.J.Teorey - Database Modeling & Design, 3rd edition, Harcourt Asia Pte. Ltd., New

Delhi, 2002.

Course Outcomes:
After undergoing the course, Students will be able to:

- Identify advance database concepts and database models.
- Apply and analyze various terms related to transaction management in centralized and distributed database.
- Produce data modeling and database development process for object –oriented DBMS.
- Analyze and Implement the concept of object- relational database in development of various real time software.
- Examine the issues related to multimedia and mobile database performance.

MSCS- 205:Lab III (Advanced Operating Systems and Advanced Computer Networks)

Operating System Lab. : 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. [50%]

Network Lab. : Implementation of different algorithms encountered in networking; hands – on experiencing with networking. [50%]

Course Outcomes:

After completion of course student will be able to

- Understand the implementation and working principles of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files and page replacement policies.
- Understand the high-level structure of the Linux kernel.
- Identify the commands such as echo, printf, ls, date, passwd cal etc with options. Experimenting with user terminal, displaying characteristics and setting them
- Understand the practical approach to network communication protocols.
- Design and implement various network application such as data transmission between client and server, file transfer, real-time multimedia transmission.
- Understand the various Routing Protocols/Algorithms and Internetworking.

MSCS-206: Lab IV (AI & Applications and Advanced DBMS)

DBMS Lab. : Detailed study of Oracle DBMS, interacting with SQL and PL/SQL. [50%]

AI Lab: Study of PROLOG. Write the following programs using PROLOG (e.g:1. Write a program to solve 8 queens problem 3 Solve any problem using depth first search. 4 Solve any problem using best first search. 5 Solve 8-puzzle problem using best first search 6 Solve Robot (traversal) problem using means End Analysis 7 Solve traveling salesman problem.) [50%]

Course Outcomes:

- Apply the basic concepts of Database Systems and Applications.
- Use the basics of SQL and construct queries using SQL in database creation and interaction.
- Design a commercial relational database system (Oracle, MySQL) by writing SQL using the system.
- Analyze and Select storage and recovery techniques of database system.
- Identify and specify and write a problem definition for a given real world problem domaim using PROLOG.

MSCS -301: Compiler Design

Unit I: Overview of Compiler: Overview of a compiler; structure, phases and passes of compiler; problems of compiler design; application of compiler design technology; interdependencies between compiler and computer architecture. [5%]

Unit II: Formal Languages: Elements of formal language theory. Regular Languages: Regular grammars, regular expressions, finite state automata; conversions; state minimization. [20%]

Unit III: Lexical Analysis: Lexical analysis vs. parsing; tokens, patterns, lexemes; input buffering; specification and recognition of tokens; lexical analyser. [15%]

Unit IV: Syntax Analysis / Parsing: Context free grammar; parse trees and derivations; ambiguity; elimination of left recursion and left factoring; top-down parsing: recursive-descent parsing, predictive parsing, LL(1) parsers; bottom – up parsing: shift-reduce parsing, conflicts; LR parsing (simple, canonical, look ahead); operator precedence parser. [30%]

Unit V: Intermediate Code Generation: Syntax Directed Translation. Synthesized and Inherited attributes. Dependency Graph. Three Address Code Representation. Symbol table management. Syntax trees. Type checking, Control flow statements. Back-patching. [20%]

Unit VI: Code Generation and Optimization: Directed Acyclic Graph (DAG), Runtime storage management. Peephole optimization. Compiler writing tools. [10%]

Reference Books:

1) *Compilers – Principles, Techniques & Tools: Aho, Sethi & Ullman, Addison Wesley.*

2) Compiler Design in C: Holub, PHI.

3) Compiler Design: Dhamdhere.

4) Principles of Compiler Design: Alfred V. Aho & Jeffrey D. Ullman, Narosa

Course Outcomes:
After undergoing the course, Students will be able to:

- Understand fundamentals of compiler and identify the relationships among different phases of the compiler.
- Understand the application of finite state machines, recursive descent, production rules, parsing, and language semantics.
- Analyze & implement required module, which may include front-end, back-end, and a small set of middle-end optimizations.
- Use modern tools and technologies for designing new compiler.

MSCS-302: Discipline-centric Elective (E1)

E1-A: Machine Learning

Unit I: Introduction: what is ML; Problems, data, and tools; Visualization; Matlab (I). Linear regression; SSE; gradient descent; closed form; normal equations; features. Overfitting and complexity; training, validation, test data, and introduction to Matlab (II). Classification problems; decision boundaries; nearest neighbor methods. [25%]

Unit II: Probability and classification, Bayes optimal decisions. Naive Bayes and Gaussian class-conditional distribution. Linear classifiers. Bayes' Rule and Naive Bayes Model. Logistic regression, online gradient descent, Neural Networks. [25%]

Unit III: Decision tree, Ensemble methods: Bagging, random forests, boosting, A more detailed discussion on Decision Tree and Boosting. Unsupervised learning: clustering, k-means, hierarchical agglomeration. Advanced discussion on clustering and EM. [25%]

Unit IV: Latent space methods; PCA, Text representations; naive Bayes and multinomial models; clustering and latent space models. VC-dimension, structural risk minimization; margin methods and support vector machines (SVM). Support vector machines and large-margin classifiers. Time series; Markov models; autoregressive models. [25%]

Reference Books:

1) Tom Mitchell, Machine Learning.

2) Ethem Alpaydin, Introduction to Machine Learning, Second Editio.

3) Stephen Marsland, Machine Learning: An Algorithmic Perspective.

4) Christopher M. Bishop, Pattern Recognition and Machine Learning.

Course Outcomes:
After undergoing the course, Students will be able to:

- Explain Machine Learning concepts, classifications of Machine Learning and write simple programs using python.
- Describe Supervised Learning concepts.
- Explain Support Vector Machine concepts.
- Describe unsupervised learning concepts and dimensionality reduction techniques.
- Discuss simple Machine Learning applications in a range of real-world applications using Python programming.

E1-B: Cryptography and Network Security

Unit 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. [10%]

Unit II: Symmetric block ciphers, DES, Gallois field, polynomial arithmetic, AES, Principles of S Box design, Block cipher design principles, Other Block ciphers. [10%]

Unit III: Introduction to public key cryptography, Number theoretic foundations, public key cryptography principles, RSA encryption system, primality testing, Number theoretic algorithms, Attacks on RSA. [20%]

Unit IV: Discrete Logarithm and Diffie-Hellman Key exchange, ElGamal system, Digital Signature, RSA and ElGamal based Digital signature, DSA, different attacks on digital signatures. [15%]

Unit V: Secure hash functions, Understanding Collisions, Secure Hash Algorithms, SHA, HMAC, Key establishment and key management, Digital Certificates. [10%]

Unit VI : Advanced topics on cryptography: Integer factorization, Strong primes, distribution of Primes, Lattice based cryptography, Introduction to Elliptic curves, Introduction to Elliptic curve based cryptography, Secret Sharing, Zero Knowledge Proof. [15%]

Unit VII: Authentication, e mail security, Kerberos, x.509 directory authentication services, PGP, S/MIME. Overview of IP security, IP security architecture, authentication header, encapsulating security pay load, combing security associations. [10%]

Unit VIII: Introduction to web security, web security requirements, SSL & transport layer security, SET network management security. Basics of system security, intruders, viruses-related threats, firewalls, design principles, trusted systems. [10%]

Reference Books:

1) William Stallings, Network Security Essentials Applications and Standards, Pearson Education.

2) Kaufman, Network Security: Private Communication in a Public World, Pearson Education.

3) William Stallings, Cryptography and Network Security, Pearson Education.

4) Hoffstein, Pipher, Silverman, An Introduction to Mathematical Cryptography, 2nd Ed. Springe.

Course Outcomes:
After undergoing the course, Students will be able to:

- To understand basics of Cryptography and Network Security.
- To be able to secure a message over insecure channel by various means.
- To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
- To understand various protocols for network security to protect against the threats in the networks.

E1-C: Software Project Management

Unit I: Basic: What is project? , What is project Management?, The role of project Manager , The project Management Profession . Project life cycle. [10%]

Unit II: Technology Context: A system view of project management, Understanding organizations, Stakeholder management, Project phases and the project life cycle , The context of information technology projects. [10%]

Unit III: Introduction: Developing the project schedule. Project management software tools. Developing the project budget. Finalizing the project schedule and budget. Monitoring and controlling the project . The project communications plan . Project metrics . Reporting performance and progress. Information distribution. [20%]

Unit IV: The importance of project risk management: Risk management planning . Common sources of risk on information technology projects. Risk identification. Qualitative risk analysis. Quantitative risk analysis. Risk response planning . Risk monitoring and control. Using software to assist in project risk management. [20%]

Unit V: The importance of project procurement management: Planning purchase and acquisitions. Planning contracting. Requesting seller responses. Selecting sellers. Administering the contract. Closing the contract. Using software to assist in project management. Outsourcing. [20%]

Unit VI: Change management: The nature of change. The change management plan. Dealing with resistance and conflict. [10%]

Unit VII: Leadership & Ethics in Projects: Project leadership. Ethics in projects. Multicultural projects: a. Project implementation b. Administrative closure c. Project evaluation. [10%]

Reference Books:

1) Information Technology Project Management: Kathy Schwalbe Thomson Publication.

2) Information Technology Project Management providing measurable organizational value Jack Marchewka Wiley India.

3) Applied software project management Stellman & Greene SPD.

4) Software Engineering Project Management by Richard Thayer, Edward Yourdon WILEY INDIA.

Course Outcomes:

After undergoing the course, Students will be able to:

- Identify the different project contexts and suggest an appropriate management strategy.
- Practice the role of professional ethics insuccessful software development.
- Identify and describe the key phases of project management.
- Determine an appropriate project management approach through an evaluation of the business context and scope of the project.

E1-D: Data Mining

Unit I: Introduction: Data – Types of Data, Data Mining Functionalities , Interestingness of Patterns – Classification of Data Mining Systems , Data Mining Task Primitives ,Integration of a Data Mining System with a Data Warehouse ,Data Preprocessing. [20%]

Unit II: Association Rule Mining and Classification : Mining Frequent Patterns, Associations and Correlations ,Mining Methods , Mining various Kinds of Association Rules , Correlation Analysis , Constraint Based Association Mining ,Classification and Prediction ,Basic Concepts , Decision Tree Induction , Bayesian Classification , Rule Based Classification , Classification by Back propagation , Support Vector Machines , Associative Classification , Lazy Learners , Other Classification Methods , Prediction. [40%]

Unit III: Clustering and Trends in Data Mining: Cluster Analysis , Types of Data – Categorization of Major Clustering Methods , K-means– Partitioning Methods , Hierarchical Methods , Density-Based Methods ,Grid Based Methods , Model-Based Clustering Methods , Clustering High Dimensional Data , Constraint ,Based Cluster Analysis – Outlier Analysis , Data Mining Applications. [40%]

Reference Books:

1) Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012.

2) Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Person Education, 2007.

3) K.P. Soman, Shyam Diwakar and V. Aja, "Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006.

4) G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, 2006.

5) Daniel T.Larose, "Data Mining Methods and Models", Wiley-Interscience, 2006.

Course Outcomes:

After undergoing the course, Students will be able to:

- Design a data mart or data warehouse for any organization.
- Develop skills to write queries using DMQL.
- Extract knowledge using data mining techniques.
- Adapt to new data mining tools.
- Explore recent trends in data mining such as web mining, spatial-temporal mining.

E1-E: Object Technology Using JAVA

Unit I: Introduction: Java as Object Oriented Language, Internet Language. Review of Object Oriented Program: Constructors. Exception handling. Inner class. User defined packages. Interface. [20%]

Unit II: Multithreaded Programming: Overview of Threads, Creating Threads, Synchronization, Deadlock, Thread Communication. [15%]

Unit II: Java Applet: Overview, Life cycle of Applet, Applet – Graphics Class, Colours, Displaying Text, Applet Dimensions, Applet in web page, Applet Class, Appletcontext Class, using Threads and Images. Abstract Window Toolkit: Labels, Buttons, Canvases, Check Boxes, Choices, Text field and Text Areas, Lists, Scroll bars, Layout Manger, Panels, Frame, Menu Bar, Dialog Box. [15%]

Unit IV: Introduction to Event Handling: Event Model, Event Class, Event Listeners, Adapter Class, Inner Class. [10%]

Unit V: Java Database Connectivity (JDBC): Introduction, PreparedStatement Interface, CallableStatement Interface, DatabaseMetadata Interface – Getting Driver Information, Working with Tables, Stored Procedures; Working with ResultsetMetadata Object, Using Trandsactions, Using Java.sql with Applets, Session. [20%]

Unit VI: Object Serialization and Remote Method Invocation (RMI): Interlocution, Distributed Object Model; RMI – Architecture, Stub and Skeleton, Layer, Remote Reference Layer, Transport Layer, Remote Registry; Package of RMI; Implementing RMI – The Server, The Client. [10%]

Unit VII: Java Servlet: Introduction, The Three-tier application architecture, Working of a Web Server, Basic, Servlet Structure, Servlet Life Cycle, Servlet API and the anatomy of a Servlet – Servlet Interface, GenericServlet Class, HttpServlet Class. Java Server Page: Introduction, Architecture of JSP, JSP API, Life Cycle of JSP. Interaction with Database using JSP, JSP to Servlet Interaction. [10%]

Reference Books:

1) Core Java-2 Volume I & Volume II – Cay S. Horstmann, Gray Cornell, Pearson Education.

2) Teach Yourself Java - Joseph O'Neil, Heb Schildt, TMH.

Course Outcomes:

After undergoing the course, Students will be able to:

- Learn how to download, setup and configure the Spring Framework.
- Explore the Spring Container and Modules.
- Understand dependency injection.
- Learn aspect oriented programming and how it is used to provide cross cutting concerns.
- Understand how Spring deals with transaction management and ORM.
- Hibernate: Inheritance mapping collection mapping.
- Understand the HQL.

E1-F: Soft Computing

Unit I: Introduction: What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing. [10%]

Unit II: Neural Networks: What is Neural Network, Learning rules and various activation functions, Single layer Perceptr , Back Propagation networks, Architecture of Backpropagation(BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications. [20%]

Unit III: Fuzzy Systems: Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification. [20%]

Unit IV: Genetic Algorithm: History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization. [20%]

Unit V: Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems. [10%]

Unit VI: GA based Backpropagation Networks: GA based Weight Determination, K - factor determination in Columns. [10%]

Unit VII: Fuzzy Backpropagation Networks: LR type Fuzzy numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP, Application of Fuzzy BP Networks. [10%]

Reference Books:

1) Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.

2) Genetic Algorithms: Search and Optimization, E. Goldberg.

3) Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.

4) Build_Neural_Network_With_MS_Excel_sample by Joe choong.

Course Outcomes:
After undergoing the course, Students will be able to:

- Learn soft computing techniques and their applications.
- Analyze various neural network architectures.
- Define the fuzzy systems.
- Understand the genetic algorithm concepts and their applications.
- Identify and select a suitable Soft Computing technology to solve the problem; construct a solution and implement a Soft Computing solution.

E1-G: Block Chain Technology

Unit I: Introduction to Blockchain. Cryptography Primitives and Bitcoin .Consensus algorithms. [25%]

Unit II: Permissioned Blockchain. Hyperledger Fabric. [25%]

Unit III: Blockchain Use Cases – Finance, Industry, Government. [25%]

Unit IV: Blockchain Security. Security and Research Aspects. Research Aspects in Blockchain. Blockckahin and Big Data. [25%]

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: Unlocking Digital Cryptocurrencies.

3) Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.

4) DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014.

5) Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts.

Course Outcomes:

- To give students the understanding of emerging abstract models for Blockchain Technology and to familiarise with the functional/operational aspects of cryptocurrency eco-system.
- Analyze the structure and components of permissioned blockchains with a focus on Hyperledger Fabric.
- Evaluate blockchain security mechanisms and ongoing research trends in the field.

E1-H: May be opted from SWAYAM

MSCS-303: (Term Paper): Minor Project

A real 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 teachers.

MSCS-304-Generic Elective (GE):

A: Internet and E-Commerce

Unit I: Introduction to E-Commerce: Defining Commerce; Main Activities of Electronic Commerce; Benefits of E-Commerce; Broad Goals of Electronic Commerce; Main Components of E-Commerce; Functions of Electronic Commerce – Communication, Process Management, Service Management, Transaction Capabilities; Process of E-Commerce; Types of E-Commerce; Role of Internet and Web in E-Commerce; Technologies Used; E-Commerce Systems; Pre-requisites of E-Commerce; Scope of E-Commerce; E-Business Models. Various Activities of E-Commerce; Various Modes of Operation Associated with E-Commerce. Elements and Resources Impacting E-Commerce and Changes. [40%]

Unit II: E-Security: Early Ages of Internet; Networking Categories; Characteristics of Internet; Components of Internet – Internet Services, Elements of Internet, Uniform Resource Locators, Internet Protocol; Shopping Cart, Cookies and E-Commerce Security on the Internet; Network and Website Security Risks – Denial-of-Service attacks, Viruses, Unauthorized access to a computer network; Vulnerability of Internet Sites; Network and

Website Security – Transaction security and data protection, Security audits and penetration testing; E-Business Risk Management Issues; Firewall – Network policy, Advanced authentication mechanism, Packet filtering, Application gateways; Defining Enterprise Wide Security Framework. [30%]

Unit III: E-Payment Systems: Electronic Funds Transfer; Digital Token Based E-Payment Systems; Modern Payment Systems; Steps for Electronic Payment; Payment Security; Net Banking,Challenges of e-payment System and Remedies.

[30%]

Reference Books:

1) E-Commerce 2010 (6th edition) by Kenneth Laudon and Carol Guercio Traver.

2) Complete E-Commerce Book: Design, Build and Maintain a Successful Web-Based Business (Revised) byJanice Reynolds ,Roya Mofazali.

Course Outcomes:
After Completion of the subject student should able to:

- Understand the basic concepts and technologies used in the field of management information systems.
- Define the security controls sufficient to provide a required level of confidentiality, integrity, and availability in an organization's computer systems and networks.
- Have the knowledge of the different types of management information systems.
- Understand the processes of developing and implementing information systems.
- Be aware of the ethical, social, and security issues of information systems.

B: Web Security

Unit I: Web Basics: HTML, CSS, JS, URLs, DOM, Frames, HTTP, Navigation, X-Domain communication. Network Attacks & HTTPS. Limitations of HTTPS. Same Origin Policy & Web Attacker Model Injection Flaws (I): Cross-site Scripting (XSS). [40%]

Unit II: Injection Flaws : XSS (contd.), SQL Injection, OS Command Injection, HTTP Header Injection. (I) Authentication Flaws:Request Authorization Flaws. Insecure Web Logic: Logic Flaws, HTTP Pollution, HTTP Parameter Tampering. Cookie Flaws and Server Misconfiguration. Attacks on User Interfaces. Browser Design & Flaws. User Privacy: Browser & Device Fingerprinting, User Tracking, Browser Caching Flaws. [60%]

Reference Books:

1) Hacking: The Art of Exploitation (2nd Ed.): Jon Erickson.

2) Digital Forensics and Incident Response:Gerard Johansen.

3) Cyber Security: Jocelyn O. Padallan.

Course Outcomes:
After undergoing the course, Students will be able to:

- Protect and defend computer systems and networks from cybersecurity attacks.
- Define the security controls sufficient to provide a required level of confidentiality, integrity, and availability in an organization's computer systems and networks.
- Diagnose and investigate cybersecurity events or crimes related to computer systems and digital evidence.
- Understand key terms and concepts in Cryptography, Governance and Compliance.
- Understand principles of web security and to guarantee a secure network by monitoring and analyzing the nature of attacks through cyber/computer forensics software/tools.

C: Introduction to Artificial Intelligence

Unit I: Introduction: Importance of Artificial Intelligence (AI). [5%]

Unit II: Problem solving using AI approach: Water-jug problem, missionary carnival problem,8-Puzzel problem, vacuum-cleaner problem, travelling-salesman problem, N-Queen problem,Wampus world problem. [10%]

Unit III: Knowledge: Its representation, Organisation, Manipulation and Acquisition. [5%]

Unit 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. [10%]

Unit V: AI Programming Languages: Introduction to PROLOG and LISP. [20%]

Unit VI: Production Systems and Search Strategies: Production System and its variants, Search Methods, Heuristic Search Methods , AND/OR Graphs and AO* Algorithm, Searching Game Trees. [10%]

Unit VII: Soft Computing and Uncertainty Management: Introduction to Fuzzy Logic, NN and GA; Bayesian inferencing, Dempster-Shafer theory of Beliefs. [10%]

Unit VIII: Structured Representation of Knowledge and reasoning: Semantic Networks, Frames, Scripts, and Conceptual Dependency. [8%]

Unit IX: Expert Systems(ES): Rule Based Expert System Architecture, Non-production System Architecture, Neural Network based ES, Knowledge Acquisition Methods, Explanation Methods, Case study: Mycin; Expert System Shells. [12%]

Unit X: Introduction to Pattern Recognition, Natural Language Processing, Planning, etc. [10%]

Reference Books:

1) Introduction to Artificial Intelligence & Expert System by D.W. Patterson, PHI.

2) Introduction to Artificial Intelligence by Rich & Knight.

3) Principle of Artificial Intelligence by N.J. Nilson, Narosa.

Course Outcomes:
After undergoing the course, Students will be able to:

- Understand the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.
- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.
- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
- Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

D: Cryptography

Unit I: Introduction to security, History and overview of Cryptography, key and message space, attacks models, security services, model for network security, internet standards. Introduction to Steganography. 10%]

Unit II: Basic types of character based ciphers, transposition and substitution ciphers and their cryptanalysis. [20%]

Unit III: Block cipher, Design principles of Block ciphers, Design of DES, AES.[10%]

Unit IV: Introduction to public key cryptography, public key algorithms, RSA cryptography. [20%]

Unit V: Discrete logarithm and Key exchange, public key cryptography algorithms, digital signatures, secure hash functions. [20%]

Unit VI: Introduction to web security, viruses-related threats, firewalls, passwords, password managements, key establishment and Key management [20%]

Reference Books:

1) William Stallings, Network Security Essentials Applications and Standards, Pearson Education.

2) Kaufman, Network Security: Private Communication in a Public World, Pearson Education.

3) William Stallings, Cryptography and Network Security, Pearson Education.

Course Outcomes:
After undergoing the course, Students will be able to:

- Describe network security services and mechanisms.
- Symmetrical and Asymmetrical cryptography.
- Data integrity, Authentication, Digital Signatures.
- Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.

E: Introduction to Programming

Unit I: Introduction to Computer Systems, Introduction to programming, Understanding basics of python. [20%]

Unit II: Branching and Decision making. Problem solving using branching. [20%]

Unit III: Loops and control structures. Problem solving using loops. [20%]

Unit IV: Functions, lists, tuples, dictionaries and other advanced features of python programming language. [20%]

Unit V: Introduction to Packages, numpy, numerical and linear algebraic problem solving using python. [20%]

Reference Books:

1) Hadoop with Python by Zachary Radtka and Donald Miner.

2) Python Cookbook by By David Beazley and Brian K. Jones.

3) Functional Programming in Python by David Mertz.

4) Python in Education by Nicholas Tollervey.

Course Outcomes:
After undergoing the course, Students will be able to:

- Explain the basic concepts of object-oriented programming and structured programming.
- Apply simple programming constructs.
- Use stepwise refinement to solve problems.
- Develop methods.
- Develop, debug and test application programs.

MSWM-304: May be opted from SWAYAM

MSCS- 305: Lab V (Compiler Design)

Compiler Design Lab. : Implementation of different compiler design principles.

Course Outcomes:
After undergoing the course, Students will be able to:

- Understand the practical approaches of how a compiler works.
- Understand and analyze the role of syntax and semantics of Programming languages in compiler construction.
- Apply the techniques and algorithms used in Compiler Construction in compiler component design.
- To use different tools in construction of the phases of a compiler for the mini language.

MSCS-306: Lab VI (Discipline-centric Elective: E1)

Implementation of programs related to Elective E1 offered. For implementation purposes, C/C++/Java/Python may be used. If there exists specific tools(offline or web) or languages for some elective papers, then those tools/languages may be used for implementations if that elective is offered.

Course Outcomes:

- After undergoing the course, students will be able to identify, specify and simulate some real world problems associated with different elective papers. Which may they can apply to demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.

MSCS 307: Community Engagement Activities

Each student is to carry out some work related to the development/welfare of a community/society as per the guidelines of the Department to be framed from time to time.

MSCS – 401: Discipline-centric Elective (E2):

E2-A: Operation Research and Optimization

Unit I: Linear Programming Problems (LPP): Basic LPP and Applications; Various Components of LP Problem Formulation. Solution of Linear Programming Problems: Solution of LPP: Using Graphical Method; Definitions: Feasible Solution, Basic and non-basic Variables, Basic Feasible Solution, Degenerate and Non-degenerate Solution, Convex set and explanation with examples. Solution of LPP by Simplex Method; Charnes' Big-M Method; Duality Theory. Integer Programming. Transportation Problems and Assignment Problems and variations. [40%]

Unit II: Network Analysis: Shortest Path: Floyd Algorithm; Maximal Flow Problem (Ford-Fulkerson); PERT-CPM (Cost Analysis, Crashing, Resource Allocation excluded). Single source shortest path and all pair shortest path. Maximum flow problem. Inventory control. Decision analysis. [25%]

Unit III: Game Theory: Introduction; 2-Person Zero-sum Game; Saddle Point; Mini-Max and Maxi-Min Theorems (statement only) and problems; Games without Saddle Point; Graphical Method; Principle of Dominance. [25%]

Unit IV: Queuing Theory: Introduction; Basic Definitions and Notations; Axiomatic Derivation of the Arrival & Departure (Poisson Queue). Poisson Queue Models: (M/M/1): (∞ / FIFO) and (M/M/1: N / FIFO) and problems. [10%]

Reference Books:

1) G. Hadley: Linear Programming. Narosa, Reprint, 2002.

2) G. Hadley: Linear Algebra, Narosa, Reprint, 2002.

3) Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010.

4) A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, 2005.

5) F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata Mc-Graw Hill, 2010.

Course Outcomes:

After undergoing the course, Students will be able to:

- Formulate and solve problems as networks and graphs.

- Construct linear integer programming models and discuss the solution techniques.
- Set up decision models and use some solution methods for nonlinear optimization problems.
- Propose the best strategy using decision making methods under uncertainty and game theory.
- Solve multi-level decision problems using dynamic programming method.
- Use computer softwares to solve decision models.

E2-B: Model Checking

Unit I: Propositional logic. Predicate logic.System verification concept. Program verification. [25%]

Unit II: Modeling systems as Finite-state machines. Introduction to model-checker. Linear-time properties. Regular properties .Omega-regular properties. [25%]

Unit III: Linear Temporal Logic (LTL) Algorithms for LTL. Computation Tree Logic (CTL). [25%]

Unit IV: Binary Decision Diagrams: Representing Bollean functions. Algorithms for reduced OBDDs. Symbolic Model checking. [25%]

Reference Books:

1) Principles of Model-checking, By Christel Baier and Joost-Pieter Katoen, MIT Press (2008).

Course Outcomes:
At the end of the course students:

- Able to identify novel and significant open research questions in electrical engineering and computer science and are able to situate such questions in the contexts of current research literature.
- Are able to apply their knowledge of computing, mathematics, science and engineering to the analysis of technological problems, as well as to the design and implementation of viable solutions to those problems.
- Are able to conduct experiments and computational simulations for the purpose of evaluating and comparing proposed solutions on the basis of empirical evidence.
- Communicate effectively through oral, visual an and written means, effectively addressing a broad range of technical audiences.

E2-C: Bioinformatics

Unit I: Introduction to Bioinformatics: Introduction to Bioinformatics, basics of bioinformatics, introduction to DNA, RNA and Protein. Fundamentals of Protein structures, Fundamentals of DNA and RNA structures, different functional units, different forces, different types of bonds. types and functions of protein and nucleic acids, Central dogma of life. Recent challenges in bioinformatics, role of computer science in bioinformatics. [10%]

Unit II: Primary Sequence Analysis: Introduction to primary sequence, basic concept of sequence similarity, pairwise sequence alignment, Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM, matrix derivation methods and principles. String matching algorithms, Concept of different distance measurement techniques, Needleman-Wunsch algorithm, Wagner-Fischer algorithm, Smith-Waterman algorithm, Hirschberg's algorithm, gap and gap penalty. Introduction to multiple sequence alignment, multiple sequence alignment algorithms, BLAST, FASTA, Dot Plots. Multiple sequence alignment tools. [30%]

Unit III: Introduction to Bioinformatics databases: Introduction, History, Primary Sequence databases, structural data bases. Types of Biological data, Genomic DNA, cDNA, rDNA, ESTs, GSSs.Nucleotide sequence databases(GenBank, EMBL, DDBJ), Protein Sequence Databases (UniProtKB, UniProt, TrEMBL).
Introduction to Secondary and Derived Databases: PDB, RCSB, NDB, MMDB, SCOP, CATH, FSSP, CSA, KEGG ENZYME, BRENDA, Sequence-motifs Databases.
Introduction to File Formats: Sequence file formats, Secondary file formats like pdb, mmCIF, xlf. [10%]

Unit IV: Secondary Structure Analysis: primary structure, secondary structure, tertiary

structure and quaternary structure. Structure visualizers such as Rasmol, Pymol, VMD, Chimera.

Introduction to Protein Structures: Torsion angle, Ramachandran plot. Introduction to Protein structure visualization and analysis tools (Both standalone and web versions), Procheck, DSSP.

Nucleic acid structure: Introduction to base pairing, base pair geometry and parameters, types of base pairing, canonical and non canonical base pairings, DNA double helix, RNA double helix, stem-loop structure of RNA, cloverleaf two dimensional structure of tRNA, Introduction to Nucleic Acid visualization and analysis tools(both standalone and web versions), VARNA, DSSR, 3DNA, Curves, NUPARM, BPFIND. [30%]

Unit V: Structure prediction: Introduction, Protein secondary structure prediction (Chou-Fasman method, Garnier-Robson method), RNA structure prediction, Nussinov's algorithm, Zuker's algorithm, other state-of-the-art algorithms for protein and nucleic acid structure predictions, Homology modeling. [20%]

Reference Books:

1) Introduction to bioinformatics, Arthur M. Lesk.

2) Bioinformatics: Sequence and Genome Analysis, David W. Mount.

3) Structural Bioinformatics, edited by Phil Bourne.

4) Molecular Modeling by Andrew Leach.

5) Molecular modelling by Tamar Schlick.

6) Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC Mathematical Biology & Medicine), by Sorin Draghici.

Course Outcomes:
After undergoing the course, Students will be able:

- To build in candidates a strong foundation in interdisciplinary sciences such as Computer Sciences and Biological Sciences, to develop accelerated and precise technologies for industrial problems, and prepare them for productive careers in fields of biotechnology, pharmaceutical, bioinformatics, Research, and healthcare industries.
- To address the challenges arising from the huge amount of genomic data and to overcome by analyzing and individualizing the corresponding drug responses towards appropriate drug specified dosages.

E2-D: Internet of Things

Unit I: Introduction: IOT concepts , IOT Standards , Components of IOT System. , Relevance of IOT for the future. , IOT Applications. , IOT for smart cities (Case study Smart city Barcelona) g) IOT in Indian Scenario , Challenges in IOT implementation. [20%]

Unit II: IOT concepts: Technologies that led to evolution of IOT , IOT and SCADA , IOT and M2M , IOT and Big Data. [10%]

Unit III: IOT Standards: Requirement of international standard (case study) , IOT standards in practice. , Operating platforms /systems [10%]

Unit IV: Components of IOT System: Design of IOT systems ,Development of prototypes. [5%]

Unit V: Relevance of IOT for the future: IOT in everyday life , Internet of Everything , IOT and Individual Privacy. [10%]

Unit VI: IOT Applications: Lighting as a service (case study) ,Intelligent Traffic systems (case study) , Smart Parking (case study) , Smart water management (case study). [15%]

Unit VII: IOT in Indian Scenario: IOT and Aadhaar, IOT for health services. ,IOT for financial inclusion. , IOT for rural empowerment. [15%]

Unit VIII: Challenges in IOT implementation: Big Data Management. ,Connectivity challenges. ,Mission critical applications. [15%]

Reference Books:

1) The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World from amazon.com.

Course Outcomes:

After undergoing the course, Students will be able to:

- Define the terms IoT and cloud computing.
- Describe the evolution that has led to cloud computing. ● Discuss the importance of IoT devices.
- Examine the Indian IoT landscape, privacy concerns, and challenges in implementing scalable IoT solutions.

E2-E: Web Technology

Unit I: Introduction to WWW : Protocols and programs, secure connections, application and development tools, the web browser, What is server, choices, setting up UNIX and Linux web servers, Logging users, dynamic IP Web Design: Web site design principles, planning the site and navigation. [15%]

Unit II: Introduction to HTML : The development process, Html tags and simple HTML forms, web site structure Introduction to XHTML : XML, Move to XHTML, Meta tags, Character entities, frames and frame sets, inside browser. [15%]

Unit III: Style sheets : Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, CSS2. [10%]

Unit IV: Javascript : Client side scripting, What is Javascript, How to develop Javascript, simple Javascript, variables, functions, conditions, loops and repetition. [10%]

Unit V: Advance script: Javascript and objects, Javascript own objects, the DOM and web browser environments, forms and validations DHTML : Combining HTML, CSS and Javascript, events and buttons, controlling your browser, Ajax: Introduction, advantages & disadvantages ,Purpose of it ,ajax based web application, alternatives of ajax. [15%]

Unit VI: XML : Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, Well formed, using XML with application.XML, XSL and XSLT.

Introduction to XSL, XML transformed simple example, XSL elements, transforming with XSLT. [15%]

Unit VII: PHP : Starting to script on server side, Arrays, function and forms, advance PHP Databases : Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs. [20%]

Reference Books:

1) Steven Holzner,"HTML Black Book", Dremtech press.

2) Web Technologies, Black Book, Dreamtech Press.

3) Web Applications : Concepts and Real World Design, Knuckles, Wiley-India.

4) Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel Pearson.

Course Outcomes:

- Understand the architecture of the World Wide Web, including servers, protocols, secure connections, and web design principles.
- Develop structured web pages using HTML, XHTML, and XML, and apply best practices in markup and metadata usage.
- Apply CSS for styling and layout control, and use JavaScript for client-side scripting and dynamic interactions.
- Build server-side applications using PHP and connect them with databases to create dynamic, data-driven websites.

E2-F: Deep Learning and NLP

Unit I: Introduction: Various paradigms of earning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques. [15%]
Unit II: Feedforward neural network: Artificial Neural Network, activation function, multi-layer neural network. [15%]

Unit III: Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization. [10%]

Unit IV: Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy. [15%]

Unit V: Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.

[15%]

Unit VI: Probabilistic Neural Network: Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders. [10%]

Unit VII: Deep Learning research: Object recognition, sparse coding, computer vision, natural language processing. [10%]

Unit VIII: Deep Learning Tools: Caffe, Theano, Torch. [10%]

Reference Books:

1) T1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

2) T2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.

3) R1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

4) R2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.

5) R3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

6) A. Ravindran, K. M. Ragsdell , and G. V. Reklaitis , ENGINEERING OPTIMIZATION: Methods and Applications , John Wiley & Sons, Inc. , 2016.

Course Outcomes:

After studying this course, students will:

- Understand the definition of a range of neural network models.
- Be able to derive and implement optimization algorithms for these models.
- Understand neural implementations of attention mechanisms and sequence embedding models and how these modular components can be combined to build state of the art NLP systems.
- Have an awareness of the hardware issues inherent in implementing scalable neural network models for language data.
- Be able to implement and evaluate common neural network models for language.

MSCS- 402: Discipline-centric Electives (E3):

E3-A: Mobile Computing

Unit I: Introduction to personal communications services (PCS), PCS architecture, mobility management, networks signaling.Overview of Global system for mobile communication (GSM) system, GSM architecture, mobility management, network signaling.Overview of general packet radio services (GPRS), GPRS architecture, GPRS network nodes. Basics of mobile data communication, WLAN (wireless LAN) IEEE 802.11 standard, mobile IP. [20%]

Unit II: Wireless application protocol (WAP), mobile internet standard, WAP gateway & protocols, wireless mark up languages (WML), WML script. Introduction to wireless local loop(WLL), WLL architecture, wireless local loop technologies. [20%]

Unit III: Basics of third generation (3G) mobile services, introduction to international mobile telecommunications 2000 (IMT 2000) vision, wideband code division multiple access (W-CDMA), and CDMA 2000, quality of services in 3G. [20%]

Unit IV: Global mobile satellite systems, case studies of the IRIDIUM & GLOBALSTAR systems.Wireless enterprise networks, introduction to virtual networks, blue tooth technology, blue tooth protocols. [20%]

Unit V: Support for mobility, file system consistency, world wide web, hypertext transfer protocol, hypertext markup language, some approaches that might help wireless access, system architectures, wireless application protocol & its architecture, wireless datagram protocol, wireless transport layer security, wireless transaction protocol, wireless session protocol, wireless application environment, wireless telephony application, examples stacks with WAP, mobile databases, mobile agents. [20%]

Reference Books:

1) Jochen Schiller, Mobile Communications, Addison wisely.

2) Wiiliam Stallings, Wireless Communications and Networks.

3) Rappaort, Wireless Communications Principals and Practices.

Course Outcomes:
After undergoing the course, Students will be able to:

- Apply knowledge of mathematics, science and algorithm in solving complex Computer engineering problems.

- Generate solutions by conducting experiments and applying techniques to analyze and interpret data.
- Design component, or processes to meet the needs within realistic constraints.
- Identify, formulate, and solve Software Engineering, Networking and Data Mining problems.
- Comprehend professional and ethical responsibility in computing profession.
- Express effective communication skills.
- Participate in global, economic, environmental, and societal context.
- Recognize the need for, and an ability to engage in life-long learning.

E3-B: Computer Graphics and Multimedia

Unit I: Introduction: Multisensory perception of human (sight, hearing, touch, smell, taste); meaning of multimedia; contemporary elements of multimedia: text, rich text, hypertext, pictures (images / graphics), video (motion pictures, motion video), animation, sound, braille; advantages of using multimedia in computer; recent advances in exploration of multisensory perception; application of computer graphics & multimedia: science, engineering, medical, business, journalism, industry, government, management, communication, art, entertainment, AI, games, advertising, education and training. [5%]

Unit II: Interactive Graphics System: Raster vs. vector graphics, video display unit / monitor (CRT, LCD, TFT, LED, Plasma – gas, electroluminescent (EL), vacuum fluorescent); types, construction and specification of display devices; non – linear nature of CRT monitor (to gray scale) and corresponding gamma correction; architecture of a raster graphics system, video adapter card, display standards, frame buffer, Video RAM, graphics controller and processor, MCA / PCI / AGP / PCIE interfaces, VGA / DVI / S – Video / HDMI interfaces, DAC, Video BIOS; 3D viewing devices, stereoscopic and virtual reality systems, random scan display and system; hard copy devices; types, construction and specification of different printers and plotters; logical interactive functions, physical interactive input devices (keyboard, mouse, trackball, space ball, joystick, data glove, touch panel, control dial, function switches, light pen, voice input), data generation / digitizer devices (scanner, digital camera, 3D digitizer, motion capture); input modes (request, sample, event); graphics functions; graphics standards; different contemporary graphics software, typical elements of GUI of a multimedia computer ;Human Computer Interaction (HCI). [15%]

Unit III: Colours in Graphics: Spectrum of visible light, spectral colours, colour of light source vs. visible object, human sensation to light / colour; hue / colour / dominant frequency / dominant wavelength, brightness / luminance / gray scale, purity / saturation, chromacity / chrominance (hue + saturation); intuitive description (pure colour, shade, tint, tone); concept of primary colours, non – availability of finite set of primary colours, colour matching experiments, standard primaries, CIE XYZ colour space and chromacity diagram, problem with 500 nm range colours; need for colour model and gamut; RGB model and colour cube (tri – stimulus theory of vision, chromacity coordinates of R, G, and B in NTSC standard / CIE model / colour monitors), concept of splitted vs. composite signal: NTSC YIQ, PAL

YUV, SECAM models; subtractive colour model in hardcopy devices: CMYK model and colour cube; device independent / other models: Ostwald, Munsell, HSV, HLS, CIE Lab, CIE Luv, Pantone; comparison and conversion between different colour models; indexed colour: colour look – up table; tone of graphics: continuous tone, bi – tone, half – tone.

[15%]

Unit IV: 2D Raster Graphics Generation: Concept of point, line (straight / curved) and area, shape drawing vs. area filling, Cartesian vs. polar coordinate system, non – parametric (implicit / explicit) vs. parametric representation, modelling objects using Euclidean geometry / fractal geometry / graftals / others, sequential vs. parallel algorithms, properties of conic sections (straight line, circle, ellipse, parabola, hyperbola), spirals, graphs of polynomial, trigonometric, exponential, non – linear regression, probability distribution functions, splines (interpolation and approximation), Bézier curves; difference between real object (dimensionless point based) and raster graphics (2D pixel based), basic object drawing (scan conversion) algorithms (DDA / Bresenham's midpoint line drawing, midpoint circle / ellipse drawing); maintenance of object geometry in raster graphics; area within a polygon / curved boundary; methods of polygon filling: scan – line (parity scan, ordered edge fill, edge fill, edge flag), seed fill (boundary, flood, soft, tint fill); dealing with inside / outside region of a complex polygon (odd – even rule, exterior rule, non – zero winding rule); simple antialiasing techniques for achieving realistic appearance; drawing attributes.

[35%]

Unit V: Graphics Transformations: Concept of transformation, transformations before and after scan conversion (object space and image space) or both; types of transformations: geometric transformation (translation, rotation, scaling, reflection, shear), viewing transformation (windowing, clipping against rectangle / arbitrary convex polygon, scissoring, zooming, panning), coordinate transformation (affine), projection transformation (parallel / perspective projections, projection / isometric view), modelling transformation, composite transformation , image transformations (cropping, half – toning / dithering, masking, filtering, morphing, effects); 2D & 3D homogeneous coordinates; transformation matrix for 2D & 3D simple & composite geometric, projection, coordinate & dithering transformations; clipping algorithms: line clipping (Cohen – Sutherland, Cyrus – Beck, Liang – Barsky, Nicholl – Lee – Nichole), polygon clipping (Sutherland – Hodgeman, Weiler – Atherton), circle and ellipse clipping. [15%]

Unit VI: 3D Graphics Specialties: Modelling and representation of natural 3D surface, solid, particles, clouds; hidden surface (line) elimination / visible surface (line) detection techniques in object space / image space: sorting and coherence; floating horizon, haloed line, Z – buffer, A – buffer, scan – line, depth sorting, BSP, area subdivision, octree, wireframe methods; concept of illumination; concept of 3D surface rendering: transparency, shading, shadows, texture, ray tracing, radiocity.

[15%]

Reference Books:

1) Computer Graphics (C version): Donald Hearn, M. PaulineBaker, Pearson.

2) Procedural Elements for Computer Graphics: DavidF.Rogers, Tata McGraw Hill.

3) Computer Graphics Principles & Practice, 2nd Edition in C:J.D.Foley, A.van Dam, S.K.Feiner, J.F.Hughes, Pearson.

4) Principles of Interactive Computer Graphics, 2nd Edition: WilliamM.Newman, RobertF.Sproull, Tata McGraw Hill.

5) Fundamentals of Multimedia:Ze – NianLi and MarkS.Drew, Prentice Hall.

6)Principles of Multimedia, 2nd Edition, 2012:RanjanParekh, Tata McGraw Hill.

Course Outcomes:
After undergoing the course, Students will be able to:

- Introduction to computer graphics
- Point-plotting techniques
- Two-dimensional transformation
- Clipping and drawing
- Polygon Filling
- Introduction to 3-dimensional graphics

E3-C: Real Time System

Unit I: Programming languages intended for real time systems, support in ordinary programming languages, e.g. "Ada tasking".Real time operating system (RTOS) [30%]

Unit II: System support: scheduling, resource handling, Design and analysis of real time system software, Modeling and verification of real time systems. [30%]

Unit III: Reliability and fault tolerance,Interrupts,Fault recovery,Distributed real time systems, Real time communication, Real time systems for multiprocessor systems. [40%]

Reference Books:

1) C. Wang, C. Gill and C. Lu, Real-Time Middleware for Cyber-Physical Event Processing, ACM Transactions on Cyber-Physical Systems, Special Issue on Real-Time Aspects in Cyber-Physical Systems, 3(3), Article 29, August 2019.

2) C. Wang, C. Gill and C. Lu, FRAME: Fault Tolerant and Real-Time Messaging for Edge Computing, IEEE International Conference on Distributed Computing Systems (ICDCS'19), July 2019.

3) J. Li, J.-J. Chen, K. Agrawal, C. Lu, C. Gill and A. Saifullah, Analysis of Federated and Global Scheduling for Parallel Real-Time Tasks, Euromicro Conference on Real-Time Systems (ECRTS'14), July 2014.

4) J. Li, D. Ferry, S. Ahuja, K. Agrawal, C. Gill and C. Lu, Mixed-Criticality Federated Scheduling for Parallel Real-Time Tasks, IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS'16), April 2016.

Course Outcomes:

After undergoing the course, Students will be able to:

- Explain the fundamentals of interaction of OS with a computer and User computation.
- Explain the fundamental concepts of how process are created and controlled with OS.
- Develop the target system by porting RTOS.
- Compare types and Functionalities in commercial OS.
- Application development using RTOS.

E3-D: Image Processing

Unit I: Image acquisition, image model, sampling, quantization, relationship between pixels, distance measures, connectivity, image geometry, photographic film. Basics of histogram, decision of contrast basing on histogram, histogram based operations, histogram equalization. Fourier transform, DFT, FFT, properties, Walsh transform, WFT, Hadamard transform. [20%]

Unit II: Arithmetic & logical operations, operations on pixel, smoothing filters, mean, median, mode filters.Edge enhancement filters, contrast based edge enhancement techniques, low pass filters, high pass filters, sharpening filters, comparative study.Design of low pass, high pass, edge enhancement, smoothening filters in frequency domain. Basics of color image processing. [20%]

Unit III: Introduction to image compression, run length encoding, contour coding, Huffman code, compression due to change in domain, compression due to quantization compression at the time of image transmission, image compression standards. [20%]

Unit IV: Introduction to image segmentation, characteristics of segmentation, detection of discontinuities, thresholding, pixel based segmentation method, region based segmentation methods, segmentation by pixel aggregation, segmentation by sub region aggregation, histogram based segmentation, spilt and merge technique, use of motion in segmentation. [20%]

Unit V: Introduction to morphology, dilation, erosion, opening, closing, hit-and-miss transform, boundary extraction, region filling, connected components, thinning, thickening, skeletons, pruning, applications of morphology in ip. [20%]

Reference Book:

1) Gonzalez & Woods, Digital Image Processing , Addision Wesley.

2) Arthur Weeks, Fundamentals of Electronic Image Processing, PHI.

Course Outcomes:
After undergoing the course, Students will be able to:

- Review the fundamental concepts of a digital image processing system.
- Analyze images in the frequency domain using various transforms.
- Evaluate the techniques for image enhancement and image restoration
- Categorize various compression techniques.
- Interpret Image compression standards.
- Interpret image segmentation and representation techniques.

E3-E: Theory of Computing

Unit I: I**ntroduction:** Concepts of alphabet, language, grammar, automata; different proof techniques, introduction to contemporary automata theories. [10%]

Unit II: Regular Language: FA, DFA, NFA, language accepted by FAs, equivalence of DFA & NFA, state minimization of FAs, Meally machine & Moore machine and conversions from one to another, regular expressions, application of REs, laws of algebra of REs, regular grammar, equivalence of FA, RE and RG, conversion between one representation of regular language to another, Arden's theorem, closure properties of regular languages, decision properties of regular languages, equivalence of regular languages, pumping lemma for regularity, application of regular languages. [30%]

Unit III: Context – Free Languages: Introduction and formal definition of Context Free Language, Context Free Grammar and Push – Down Automata; determinism and non – determinism; different ways of designing PDAs as language acceptor, equivalence of them; equivalence of CFG and PDAs; properties of CFGs – null production, unit production, useless production, ambiguity, inherent ambiguity; introduction to parsing, parse trees, derivations, recursive inferences; normal forms of CFGs, conversion of CFGs to different normal forms; closure properties of CFLs, decision properties of CFLs, pumping lemma for CFLs, undecidable problems of CFLs; DPDA. [30%]

Unit IV: LBA and Turing Machines: Introduction to Turing machine, language accepted by Turing machine, Turing machine as an accepter or a transducer, different variants of Turing

machines, universal Turing machine, Turing machine and halting, LBA, context sensitive grammar, context sensitive language, classification and hierarchies of languages. [20%]

Unit V: Computability and Complexity: Church – Turing thesis, undesirability problems, recursive & recursively enumerable languages and their properties, Rice's theorem, Post's correspondence problem, primitive recursive function, problem reducibility, concepts of P, NP, NP – Complete, NP – Hard problems, PSPACE. [10%]

Reference Books:

1) Introduction to Automata Theory, Languages and Computation, 1st Edition: J. E. Hopcroft, J. D. Ullman, Narosa.

2) Introduction to Automata Theory, Languages and Computation, 2nd Edition: J. E. Hopcroft, R. Motwani, J. D. Ullman, Pearson.

3) An Introduction to Formal Languages and Automata: Peter Linz, Narosa.

4) Theory of Computer Science (Automata, Languages and Computation): K. L. P. Mishra & N. Chandrasekaran, PHI.

5) Elements of the Theory of Computation: H. R. Lewis and C. H. Papadimitriou.

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

- Use basic concepts of formal languages of finite automata techniques.
- Design Finite Automata's for different Regular Expressions and Languages.
- Construct context free grammar for various languages.
- Solve various problems of applying normal form techniques, push down automata and Turing Machines.

E3-F: Data Science

Introduction: Definition of Data, type of data, data collection, Date Cleaning, data pre processing, ETL techniques, data storage, data warehousing, data wrangling, Knowledge discovery, data mining, data science project life cycle, Data summaries and descriptive statistics : Measures of i) Frequency, Count, Percent, ii)Central Tendency like Mean, Median, and Mode, iii) Dispersion or Variation like Range, Variance, Standard Deviation, iv) Position like Percentile Ranks and Quartile Ranks. **[15%]**

Basics of probability: Joint Probability, Conditional Probability, Bayes Theorem, Probability distributions, Regression models **[10%]**

Testing of Hypothesis: Introduction to Hypothesis testing, ANOVA, t-test, Wilcoxon signed-rank test, Spearman's rank-order correlation,error, sampling, normalization. **[10%]**

Working with Features: Feature extraction and Feature Selection, dimensionality reduction - Principal Component Analysis **[10%]**

Data Visualization: Introduction to Data visualization Fundamentals of Graphs and Charts **[5%]**

Introduction to machine learning: Supervised, unsupervised learning, ROC, AUC, Classification: KNN, Decision Tree, Random Forest, Bayes Classifier, Support Vector Machine **[20%]**

Clustering: KMeans, FCM, DBScan, Expectation-Maximization, Agglomerative Hierarchical Clustering **[10%]**

Database Systems: Database Management System, SQL, Introduction to Big Data and Its management – Basics of Hadoop, MapReduce, NoSQL, Spark **[10%]**

Deep Learning: Basics of Deep Learning, Convolutional Neural Network, Recurrent Neural Network **[5%]**

Case Study: Case study on real-life applications of Data Science in any area like bioinformatics, image processing and computer vision, natural language processing, social networking etc. **[5%]**

Reference Books:

1. *Cady, Field. The data science handbook. John Wiley & Sons, 2017.*
2. *Pierson, Lillian. Data science for dummies. John Wiley & Sons, 2015.*
3. *Peter Bruce and Andrew Bruce, Practical Statistics for Data Science, O'Reilly, 2017.*
4. *Moreira, João, Andre Carvalho, and Tomás Horvath. A general introduction to data analytics. John Wiley & Sons, 2018.*
5. *Machine Learning, Tom Mitchell, McGraw Hill, 1997.*
6. *Introduction to Machine Learning, third edition. Ethem Alpaydin. The MIT Press. September 2014: ISBN: 978-0-262-028189*
7. *Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York.*
8. *Cory Lesmeister, Mastering Machine Learning with R.*
9. *Python Data Science Handbook, Jake VanderPlas, 2016, O'Reilly Media, Inc., ISBN: 9781491912058*
10. *Practical Statistics for Data Scientists by Peter Bruce, Andrew Bruce & Peter Gedeck, O 'Reilly,*
11. *ISBN: 149207294X*
12. *Data Science from Scratch Paperback, Joel Grus, O'Reilly, ISBN-10 : 149190142X2015.*
13. *Hands-On Machine Learning with Scikit-Learn, Keras and Tensor Flow: Concepts, Tools and*

14. *Techniques to Build Intelligent Systems, Aurelien Geron, Shroff/O'Reilly; 2019, ISBN-10:9352139054*

Course Outcomes:

After undergoing the course, Students will be able to:

- Apply mathematical principles to the analysis of data.
- Analyze very large data sets in the context of real world problems.
- Develop and implement data analysis strategies base on theoretical principles, ethical considerations, and detailed knowledge of the underlying data.
- Demonstrate an ability to articulate, assess and apply appropriate theories and principles of information management.
- Demonstrate presentation proficiency for written, oral and visual communications in the contest of traditional and digital forms of communication.
- Demonstrate an understanding of appropriate research methods used to collect and analyze data for decision-making and communications; inclusive of traditional and digital forms of communication.

MSCS -403: Major Project

Project Work: Students should complete their project work preferably in the department under the guidance of a teacher of the department. Duration of the project in the department should be about 5 months. 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).

Course Outcomes:

- Students who complete a Major Qualifying Project will apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study. demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.

MSCS -404 Seminar & Grand Viva

Course Outcomes:

- The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering.

MSCS -405 (DE Lab VII: E2)

Practicals related to Elective 2 offered. For implementation purposes, C/C++/Java/Python may be used. If there exists specific tools(offline or web) or languages for some elective papers, then those tools/languages may be used for implementations if that elective is offered.

Course Outcomes:

- After undergoing the course, students will be able to identify, specify and simulate some real world problems associated with different elective papers. Which may they can apply to demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.

MSCS - 406 (DE Lab VII: E3)

Practicals related to Elective 3 offered. For implementation purposes, C/C++/Java/Python may be used. If there exists specific tools(offline or web) or languages for some elective papers, then those tools/languages may be used for implementations if that elective is offered.

Course Outcomes:

- After undergoing the course, students will be able to identify, specify and simulate some real world problems associated with different elective papers. Which may they can apply to demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.