ANDHRA UNIVERSITY: : VISAKHAPATNAM

M.Tech Computer Science & Technology with Specialization in Artificial Intelligence & Robotics

Course Structure and Scheme of Valuation w.e.f. 2015-16

I SEMESTER

Code	Name of the subject	Periods/week		Max. Marks		Total	Credits
		Theory	Lab	Ext.	Int.		
MTCST1.1	Mathematical Foundations of Computer Science	3	-	70	30	100	4
MTCST1.2	Data Structures & Algorithms	3	-	70	30	100	4
MTCST1.3	Advanced Database Management Systems	3	-	70	30	100	4
MTCSTAIR1.4	Fundamentals of Robotics	3	-	70	30	100	4
MTCST1.5	Elective-I	3	-	70	30	100	4
MTCSTAIR1.6	Elective-II	3	-	70	30	100	4
MTCST1.7	Data Structures & Programming Lab	-	3	50	50	100	2
MTCSTAIR1.8	Robotics Lab	-	3	50	50	100	2
	Total	18	6	520`	280	800	28

Elective-I: Computer Organization & Architecture/ E-commerce/Embedded systems
Elective II: Advanced Operating System/Pattern Recognition /Natural Language Processing/Computer Graphics & Visual Computing

II SEMESTER

Code	Name of the subject	Periods/week		Max. Marks		Total	Credits
		Theory	Lab	Ext	Int.		
MTCST2.1	Artificial Intelligence	3	-	70	3	100	4
MTCSTAIR2.2	Expert Systems	3	-	70	30	100	4
MTCSTAIR2.3	Advanced Robotics	3	-	70	30	100	4
MTCST2.4	Data Warehousing & Mining	3	-	70	30	100	4
MTCSTAIR2.5	Elective III	3	-	70	30	100	4
MTCSTAIR2.6	Elective IV	3	-	70	30	100	4
MTCST2.7	Data Warehousing & Mining Lab	-	3	50	50	100	2
MTCSTAIR2.8	AI & Expert Systems Lab	-	3	50	50	100	2
MTCST2.9	Seminar	-	-	-	100	100	2
	Total	18	6	520`	380	900	30

Elective III: Neural Networks& Fuzzy Systems/ Big Data Analytics/ Semantic Web**/**Database security
Elective IV: Image Processing/ Machine Learning/ Computer Vision

III SEMESTER

M. Tech (CST, IT, CSTAIR, CSTBI, CSTCN)

Code	Name of the subject	Periods/week Theory	Max. MarkS Lab	Ext.	Total Int.	Credits
MTCST3.2	Thesis Work Part 1		Grade		Grade	10

1. Candidates can do their thesis work within the department or in any industry/research organization for two semesters (i.e. 3rd and 4th semesters). In case of thesis done in an industry/research organization, one advisor (Guide) should be from the department and one advisor (CO-Guide) should be from the industry/research organization.
2. Thesis part I should be submitted at the end of 3rd semester and it will be evaluated by a committee consisting of Chairman Board of Studies, Head of the Department and thesis guide.
3. Although credits are allotted for the thesis work they will not be taken for the calculation of CGPA.

IV SEMESTER

Code	Name of the subject	Periods/week Theory	Max. Marks Lab	Ext.	Total Int.	Credits
MTCST3.2	Thesis Work Part 2	Grade			Grade	14

1. A publication of a paper on the thesis work in a National/International Conference proceedings with presentation certificate or a paper on the thesis work be communicated to a National/International Journal & accepted for publication for the submission of thesis at the end of 4th semester is mandatory.
2. Final Thesis with Part I & Part II should be submitted at the end of 4th semester and it will be evaluated by a committee consisting of Chairman Board of Studies, Head of the Department, External Examiner and thesis guide.
3. The candidate has to defend his thesis in a Viva-voce examination to be conducted by the above committee. The committee should submit a report, with signatures of all the members, candidate wise, with grade A-Excellent/ Grade B-Good/Grade C- fair/ Grade D- Reappear.
4. The external examiner shall be nominated by the Hon'ble Vice Chancellor as per the norms of the University.
5. Although credits are allotted for the thesis work they will not be taken for the calculation of CGPA.

Detailed Syllabus for M.Tech First Semester

MTCST 1.1 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Common for M. Tech (CST, IT, CSTAIR, CSTBI, CSTCN, BTMTSE)

Instruction: 3 Periods/week	**Time: 3 Hours**	**Credits: 4**
Internal: 30 Marks	**External: 70 Marks**	**Total: 100 Marks**

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1. Mathematical notions of sets, sequences and tuples, functions and relations, Primitive recursive functions, computable functions, examples, graphs, strings and languages,

2. Boolean logic – properties and representation, theorems and types of proofs, deductive, inductive, by construction, contradiction and counter-examples.

3. Introduction to Number theory, Divisibility, modular arithmetic (addition modulo and multiplication modulo); Statements and applications of Euler and Fermat Theorems, Primitive Roots, Discrete Logarithms, Primality Test, Finding Large primes, Definition of Elliptic Curves and their applications to Cryptography.

4. Introduction To Finite Automata: Alphabets and languages- Deterministic Finite Automata – Non- deterministic Finite Automata – Equivalence of Deterministic and Non-Finite Automata – Languages Accepted by Finite Automata – Finite Automata and Regular Expressions – Properties of Regular sets &Regular Languages and their applications.

5. Context Free Languages: Context –Free Grammar – Regular Languages and Context-Free Grammar – Pushdown Automata – Pushdown Automata and Context-Free Grammar – Properties of Context-Free Languages – pushdown automata and Equivalence with Context Free Grammars.

6. Turing Machines: The Definition of Turing Machine – Computing with Turing Machines – Combining Turing Machines, , programming techniques for Turing Machines,

7. Variants of Turing Machines, Restricted Turing Machines Universal Turing Machines. The Halting Problem, Decidable & undecidable problems- Post Correspondence Problems

Text books:

1. Introduction to Automata Theory, Languages and Computations – J.E. Hopcroft, & J.D. Ullman , Pearson Education Asia.
2. Cryptography and Network Security, William Stallings.(Second Edition)Pearson Education Asia.

Reference books:

1. Introduction to languages and theory of computation – John C. Martin (MGH)
2. Discrete Mathematical structures with application to Computer Science – J.P. Tremblay and R. Manohar
3. Introduction to Theory of Computation – Michael Sipser (Thomson Nrools/Cole)
4. Cryptanalysis of number theoretic Cyphers, Samuel S. Wagstaff Jr.Champan & Hall/CRC Press 2003.
5. Network Security: The Complete Reference by Roberta Bragg, Mark Phodes –Ousley, Keith Strassberg Tata McGraw-Hill.

MTCST 1.2 DATA STRUCTURES AND ALGORITHMS

Common for M.Tech(CST, IT, CSTAIR, CSTBI, CSTCN)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**

Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. ALGORITHM ANALYSIS:
Overview of C++ classes, pointers, parameters passing, templates, using Matrices
Basics of time complexity estimates, General norms for running time calculation

2. LISTS, STACKS & QUEUES:
Abstract Data Types, Representation & implementation of ADT list, Doubly linked list, Circular linked lists, Representation, Implementation and applications of ADT stack and Queue.

3. TREES:
Implementation and traversal of trees, Binary Trees and Binary search trees in C++, Concepts of AVL Trees, Splay Trees and B-Trees.

4. HASHING:
Hash Function, Separate chains, Open addressing, rehashing, Extendible Hashing.

5. INTERNAL SORTING ALGORITHMS:
Sorting like insertion Sort, shell Sort, Heap Sort, Merge Sort, Quick Sort and Simple external Sorting algorithm.

6. DISJOINT SET:
Equivalence Relations, Find and Union algorithms an dynamic sets, Path compression and Union-by-Rank algorithm analysis.

7. GRAPH ALGORITHMS:
Representation of graph Topological Sort, shortest-path Algorithm, Network flow problem, Minimum spanning tree algorithm, Applications of Depth – First search, Introduction to NP-Completeness.

Text Book:

Data Structures & Algorithm Analysis in C++, Mark Allen Weiss. Second edition, Pearson Edition. Asia.

Reference Books:

1. Data Structures & Algorithm in C++, Adam Drozdek. Vikas publication House.
2. Data Structure, Algorithm and OOP, Gregory L. Heileman (Tata Mc Graw Hill Edition).
3. Data Structures, Algorithms and Applications in C++,Sartaj Sahni,Mc Graw-Hill International Edition.

MTCST 1.3 ADVANCED DATA BASE MANAGEMENT SYSTEMS

Common with M.Tech (CST, IT, CSTAIR, CSTBI, CSTCN)

Instruction:3 Periods/week	**Credits:4**	**Time: 3 Hours**
Internal: 30 Marks	**External: 70 M arks**	**Total: 100 Marks**

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1. **Database Systems**: Introduction to the Database Systems, Concepts of Relational Models and Relational Algebra. SQL: Introduction to SQL Queries, Integrity Constraints, Joins, Views, Intermediate and Advanced SQL features and Triggers.

2. **Database Design**: Overview of the Design process, E-R Models, Functional dependencies and other kinds of dependencies, Normal forms, Normalization and Schema Refinement.

3. **Database Application Design and Development**: User Interfaces and Tools, Embedded SQL, Dynamic SQL, Cursors and Stored procedures, JDBC, Security and Authorization in SQL, Internet Applications.

4. **Query Evaluation:** Overview, Query processing, Query optimization, Performance Tuning.

5. **Database System Architectures**: Centralized and Client-Server Architecture, Server system Architecture, Parallel and Distributed database, Object based databases and XML. Advanced data types in databases. Cloud based data storage systems.

6. **Transaction Management**: Overview of Transaction Management, Transactions, Concurrency control, Recovery systems, Advanced Transaction Processing.

7. **Case Studies**: Postgre SQL, Oracle, IBM DB2 Universal Database, Microsoft SQL Server.

Text Books:

Database System Concepts, Avi Silberschatz , Henry F. Korth , S. Sudarshan McGraw-Hill, Sixth Edition, ISBN 0-07-352332-1.

References:

Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke,McGraw-Hill.

MTCSTAIR1.4 FUNDAMETALS OF ROBOTICS

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. Introduction to Robotics:

Classification, Components, Characteristics, Applications.

2. Robotics Kinematics:

Position Analysis, Robots as Mechanisms, Matrix Representation, Transformation Matrices, Forward and Inverse Kinematics.

3. Actuators:

Characteristics of Actuating Systems, Actuating Devices and Control.

4. Sensors:

Sensor Characteristics, Description of Different Sensors.

Text Books:

1. Saeed B. Niku, Introduction to Robotics Analysis, Application, Pearson Education Asia, 2001.

Reference Books:

1. R.K.Mittal and I J Nagrath, Robotics and Control, TMH, 2003.
2. Computational Intelligence, Davis Poole, Alan Mackwath, Randy Coehel, Oxford University Press 1998.

MTCST 1.5 Elective I COMPUTER ORGANIZATION AND ARCHITECTURE

Common with M.Tech (CST, IT, CSTAIR, CSTBI, CSTCN)

Instruction: 3 Periods/week	**Time: 3 Hours**	**Credits: 4**
Internal: 30 Marks	**External: 70 Marks**	**Total: 100 Marks**

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1. Register Transfer and Micro operations:
Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit.

2. Basic Computer Organization and Design:
Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input-Output and Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic.

3. Micro programmed Control:
Control Memory, Address Sequencing, Micro program Example, Design of Control Unit.

4. Central Processing Unit:
Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer(RISC)

5. Input/output Organization:
Peripheral Devices, I/O interface, Asynchronous data transfer, Modes of transfer, priority Interrupt, Direct memory access, Input-Output Processor (IOP), Serial Communication.

6. Memory Organization:
Memory Hierarchy, Main memory, Auxiliary memory, Associate Memory, Cache Memory, and Virtual memory, Memory Management Hardware.

7. Overview of Computer Architecture:
Evolution of Computer Systems, Parallelism in Uni- processor System, Parallel Computer Structures, Architectural Classification Schemes, Parallel Processing Applications.

Text Book:

1. Computer System Architecture, M. Morris Mano, Prentice Hall of India Pvt. Ltd., Third Edition, Sept. 2008 .

2. Computer Architecture and Parallel Processing, Kai Hwang and Faye A. Briggs, McGraw Hill, International Edition1985.

Reference Book:

1. Computer Architecture and Organization, William Stallings, PHI Pvt. Ltd., Eastern Economy Edition, Sixth Edition, 2003.

2. "Computer System Architecture", John. P. Hayes.

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

MTCST 1.5 Elective I E-COMMERCE

Common with M.Tech (CST, IT, CSTAIR, CSTBI)

Instruction: 3 Periods/week	**Time: 3 Hours**	**Credits: 4**
Internal: 30 Marks	**External: 70 Marks**	**Total: 100 Marks**

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1. **Introduction:** Electronic Commerce-Frame Work, Anatomy of E-Commerce Applications, E-Commerce Consumer Applications, E-Commerce Organization Applications. Consumer Oriented Electronic Commerce - Mercantile Process Models, Digital Economy and e-business Models
2. **Electronic Payment Systems** – Types of Electronic Payment Systems, Digital Token-Based, Smart Cards, Credit Cards, Risks in Electronic Payment Systems, Designing Electronic Payment Systems Electronic Data Inter Change, Inter Organizational Commerce - EDI, EDI Implementation, Value Added Networks.
3. **Intra Organizational Commerce**, Macro Forces And Internal Commerce, Work Flow Automation and Coordination, Customization And Internal Commerce, Supply Chain Management. Business Cases for Document Library, Digital Document Types, Corporate Data Ware-Houses.
4. **Advertising And Marketing:** Information Based Marketing, Advertising On Internet, Online Marketing Process, Market Research. Consumer Search and Resource Discovery, Information Search and Retrieval, Commerce Catalogues, Information Filtering.
5. **Multimedia-Key Multimedia Concepts,** Digital Video and Electronic Commerce, Desktop Video Processing, Desktop Video Conferencing.
6. **Business to consumer e-commerce:** On line Marketing and Selling, Information Goods, Electronic Markets and Auctions on the Internet
7. **E-Business Intelligence:** Data Mining, Web Merchandising and Recommender Systems, Intelligent Agents in e-commerce, Business-to-Business e-commerce and Supply Chain Management
8. **Security of Internet** Hosts and Networks, Public Key Infrastructure, Safety of e-commerce Applications

Text Books:

1. Frontiers of Electronic Commerce, Kalakata and Whinston, Pearson.

References:

1. E-Commerce fundamentals and Applications, Hendry Chan, Raymond Lee, Tharam Dillon, Ellizabeth Chang, John Wiley.
2. E-Commerce, S.Jaiswal, Galgotia.
3. E-Commerce, Efrain Turbon, Jae Lee, David King, H.Michael Chang.
4. E-Commerce - Business, Technology and Society, Kenneth C.Taudon, Carol Guyerico Traver.

MTCST 1.5 Elective I EMBEDDED SYSTEMS

Common with M.Tech (CST, IT, CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. Examples of Embedded Systems – Typical Hardware – Memory – Microprocessors – Busses – Direct Memory Access – Introduction to 8051 Microcontroller – Architecture-Instruction set – Programming.

2.Microprocessor Architecture – Interrupt Basics – The Shared-Data problem – Interrupt Latency.

3.Round–Robin Architecture - Round–Robin with Interrupts Architecture - Function-Queue-Scheduling Architecture – Real-Time Operating Systems Architecture – Selection of Architecture.

4.Tasks and Task States – Tasks and Data – Semaphores and Shared Data – Semaphore Problems – Semaphore variants.

5. Message Queues – Mailboxes – Pipes – Timer Functions – Events – Memory Management – Interrupt Routines in RTOS Environment.

6. RTOS design – Principles – Encapsulation Semaphores and Queues – Hard Real-Time Scheduling Considerations – Saving Memory Space – Saving Power.

7. Host and Target Machines – Linker/Locator for Embedded Software- Getting Embedded Software into the Target System.

8. Testing on your Host Machine – Instruction Set Simulators – Laboratory Tools used for Debugging.

Text Book:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J. Ayala, Penram International.
2. An Embedded Software Primer, David E. Simon, Pearson Education , 2005.

Reference Book:

Embedded Systems: Architecture , Programming and Design, Raj Kamal, Tata McGraw-Hill Education, 2008

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MTCSTAIR 1.6 Elective II ADVANCED OPERATING SYSTEMS

Common for M.Tech (CSTCN,CSTBI, CSTAIR)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**

Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. Introduction To Operating Systems, Types Of Operating Systems, Operating System Structures. Operating-System Services, System Calls, Virtual Machines, Operating System Design And Implementation.
2. **Process Management**: Process Concepts, Operations On Processes, Cooperating Processes, Threads, Inter Process Communication, Process Scheduling, Scheduling Algorithms, Multiple -Processor Scheduling. Thread Scheduling.
3. **Process Synchronization & Deadlocks**: The Critical Section Problem, Semaphores, And Classical Problems Of Synchronization, Critical Regions, Monitors, Deadlocks,-System Model, Deadlocks Characterization, Methods For Handling Deadlocks, Deadlock- Prevention, Avoidance, Detection,& Recovery from Deadlocks.
4. **Memory Management & File System Implementation:** Logical Versus Physical Address Space, Paging And Segmentation, Virtual Memory, Demand Paging, Page Replacement Algorithms, Thrashing, File System Implementation -Access Methods, Directory Structure, Protection, File System Structure, Allocation Methods, Free Space Management, Directory Management, Device Drivers
5. **Distributed Operating Systems:** Distributed System Goals**,** Types Of Distributed Systems, Styles & Architecture Of Distributed Systems, Threads, Virtualization, Clients, Servers, Code Migration, and Communication in Distributed Systems.
6. **Distributed Systems & Synchronization:** Clock Synchronization, Logical Clocks, Mutual Exclusion, Global Positioning Of Nodes, Data-Centric Consistency Models, Client-Centric Consistency Models, Consistency Protocols.
7. **Fault Tolerance, Security:** Introduction To Fault Tolerance, Process Resilience,, Reliable Client-Server Communication, Reliable Group Communication, Distributed Commit, Recovery, Secure Channels, Access Control, Security Management

Text Books:

1. Silberschatz & Galvin, 'Operating System Concepts', Wiley.
2. "DISTRIBUTED SYSTEMS", Second edition, Andrew S.Tanenbaum, Maarten Van teen.

References:

1. William Stallings-"Operating Systems"- 5th Edition - PHI
2. Charles Crowley, 'Operating Systems: A Design-Oriented Approach', Tata Hill Co.,1998 edition.
3. Andrew S.Tanenbaum, 'Modern Operating Systems', 2nd edition, 1995, PHI.

MTCSTAIR 1.6 Elective II Pattern Recognition

(Common for CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

1. **Introduction:** Overview of Pattern Recognition- Relations of PR with other Systems, PR Applications, Different Approaches to Pattern Recognition- Statistical Approach to PR, Syntactic Approach to PR, Neural Approach to PR, Examples of PR Approaches. Other Approaches to PR.

2. **Structure of PR System:** Abstract Representation of PR Mappings, Structure of PR System, Patterns and Feature s, Feature Extraction Examples, Object Description and Classification, Figure Recognition, Numerical Results and Analysis. Feature Vector and Feature Space, training and Learning in PR System.

3. **Statistical Pattern Recognition**: Introduction, Gaussian Case and Class Dependency, Discriminate Function, Examples, Classifier Performance,

4. **Training**: Parametric Estimation and Supervised Learning, Maximum Likely Hood Estimation, Bayesian Parameter Estimation Approach , Parzen Windows, Direct Classification Using Training set., Unsupervised Learning and Clustering, Clustering for Unsupervised Learning and Classification

5. **Syntactic Pattern Recognition**: Overview of Syntactic Pattern Recognition, Grammar Based Approaches and Applications, Examples of String Generation as Pattern Description, 2-D line Drawing Description Grammar, Character Description using PDL, Object Description using Projected Cylinder Models, Block World Description Models, Heuristic Generation of Grammars,

6. Recognition of Syntactic Description, Recognition by Matching, Recognition by Parsing, CYK Parsing Algorithm, Augmented Transition Nets in Parsing, Graph Based structure representation, Structured Strategy to Compare Attributed Graphs.

7. **Neural Pattern Recognition**: Introduction to Neural Networks,, Neural Network Structure for PR Applications, Physical Neural Networks, ANN Model, NN Based PR Association, Matrix Approaches and Examples

8. Feed Forward Neural Networks And Training by Back Propagation, Hope field Approach to Neural Computing, Other related Neural Approaches and Extensions

Text Book:

1. Pattern Recognition- Statistical, Structural and Neural Approaches, Rober.J. Shelkoff, John Wiley & Sons, NY 1992,ISBN0-471-52974-5

Reference Book:

1. Neural Networks for pattern recognition, Christopher M.Bishop Oxford University Press.
2. Pattern Classification, Richard O.Duda ,Wiley India Edition

MTCSTAIR1.6 ELECTIVE II Natural Language Processing

(Common for CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. Introduction: Introduction to Natural Language Processing, Linguistic Background, Phases in Natural Language understanding, Spoken Language input and output Technologies, Written text input, Mathematical Methods, Statistical Modeling and Classification, Finite State Methods,
2. Grammars for Natural Language Processing, Parsing, Semantic and Logic Form, Ambiguity Resolution, Semantic Interpretation
3. Information Retrieval Architecture: Indexing, Storage, Compression Techniques, Retrieval Approaches, Evaluation,
4. Search Engines: Commercial Search Engine features, Comparison, Performance Measures, Document Processing, NLP Based Information Retrieval, Information Extraction.
5. Text Mining: Categorization, Extraction Based Categorization, Clustering, Hierarchical Clustering, Document Clustering and Routing,
6. Finding and Organizing Answers from Text Search, Use of Categories and Clusters for Organizing Retrieval Results, Text Categorization and Efficient Summarization Using Lexical Chains, Pattern Extraction
7. Generic Issues: Multilinguality, Multilingual Information Retrieval and Speech Processing, Multimodality, Text and Images, Modality Integration, Transmission and Storages, Speech coding, Evaluation of Systems, Human Factors and Acceptability
8. Applications: Machine Translation, transfer Metaphor, Interlingua and statistical Approaches, Discourse Processing, Dialog and Conversational agents, Natural Language Generation, Surface Realization and Discourse Planning

Text Books:

1. Speech and Language processing, Daniel Jurafsky and JamesH Martin,2000, Printice Hall
2. Foundations of Statistical Natural Language Processing, ChristopherD Manning Hinrich Schutze, MIT Press,1999

References:

1. Survey of the State of the art in Human Language Technology, Ron Cole, J. Martin, et.al, Cambridge University Press
2. Survey of Text Mining, Clustering, Classifications and Retrieval, Michael W. Berry, Springer Verog,2003
3. Natural language understanding, James Allen, Benjaman/Cumings Publishing Co.
4. Information Storage and Retrieval systems, GeraldJ Kowalskiand Mark T Maybury, Kulwer Academic Publishers,2000
5. Natural Language Information retrieval, Tomek Strzalkowski, Kulwer Academic Publishers,1999

MTCSTAIR1.6 Elective II Computer Graphics &Visual Computing

Common for M.Tech (CST, IT,CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction:** Computer Graphics and their applications, Computer Aided Design-Computer Art, Entertainment, Education and Training, Graphical User Interfaces; Over view of Graphics systems: Video Display Devices, Raster Scan systems, random scan systems, Graphics monitors and workstations, Input devices, hard copy devices, GUI and Interactive Input Methods, Windows and Icons, Virtual Reality Environments, Graphics software

2. **Output primitives:** Points and Lines, **,** Line and Curve Attributes-Color and Gray scale levels Line Drawing Algorithms, Loading the Frame buffer, Line function, Circle Generating Algorithms, Ellipse Generating Algorithms, Other Curves, Parallel Curve Algorithms, Curve Functions, Pixel Addressing, Area Fill Attributes, Filled Area Primitives, Filled Area Functions, Cell Array, Character Generation, Character Attributes, Bundled Attributes, Inquiry Functions ,Antialiasing

3. **Three Dimensional Concepts and Object representations:** 3D display methods-3D Graphics, Polygon Surfaces, Curved Lines and Surfaces, Quadratic Surfaces, Super Quadrics, Blobby Objects, Spline Representations , Cubic Spline methods, Bézier Curves and Surfaces, B Spline Curves and Surfaces,

4. **Two & Three Dimensional Transformations:** Two Dimensional Transformations: Basic Transformations, Matrix Representations, Homogeneous Coordinates, Composite Transformations, Other Transformations, Transformations between Coordinate Systems, Affine Transformations -, Transformation Functions-, Raster methods for Transformation Three Dimensional Transformatio**ns:** Translation-, Rotation, scaling, Other Transformations, Composite Transformations, 3D Transformation Functions, Modeling and Coordinate Transformations,

5. **Viewing Pipeline and structures :** Viewing Coordinates, Projections , View Volumes, General Projection Transformations, Clipping-,Hardware Implementations **,** Concepts of Structures and Basic models, Editing , Hierarchical Modeling with Structures,

6. **Visualization:** Three Dimensional Viewing, Visualization- Image Processing- The viewing Pipeline, Viewing Coordinate Reference Frame, Window-to-Viewport Coordinate Transformation, Two Dimensional Viewing Functions , Clipping Operations, Point Clipping, Line Clipping, Polygon Clipping-Curve Clipping, Text and Exterior Clipping.

7. **Visual Computing:** Computational and mathematical methods for creating, capturing, analyzing and manipulating digital photographs, Introductory Topics on computer graphics, computer vision, and machine learning, Programming assignments intended to give hands-on experience with creating graphical user interfaces, and with implementing programs for synthesizing and manipulating photographs.

8. **Visual Transformation & Projection:** Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination,

texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression, Creation of Visual Effects Optical Flow Video Compression, Radon Transform Texture

Text Book:

1. Computer Graphics C Version, Donald Hearn & M. Pauline Baker , Pearson Education, New Delhi, 2004
2. D. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, Prentice Hall Inc., 2003

Reference Books:

1. Procedural Elements for Computer Graphics, David F. Rogers, Tata McGraw Hill Book Company, New Delhi, 2003
2. Computer Graphics: Principles & Practice in C, J. D. Foley, S. K Feiner, A VanDam F. H John Pearson Education, 2004
3. Computer Graphics using Open GL, Franscis S Hill Jr, Pearson Education, 2004.
4. *Computer Vision and Image Processing: A Practical Approach using CVIPtools*, S. E. Umbaugh,, Prentice Hall, 1998

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MTCST 1.7 DATA STRUCTURES& PROGRAMMING LAB

Commonfor M.Tech (CST, IT, CSTAIR, CSTBI, CSTCN)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 2**

Internal: 50 Marks **External: 50 Marks** **Total: 100 Marks**

Implementation of Data Structures and Algorithms using C++

1. To perform various operations such as insertion, deletion, display on single linked lists.

2. To implement
(i) Stacks using linked list. (ii) Queues using linked list.

3. To perform different types of searching techniques on a given list
(i) Sequential search (ii) Binary search (iii) Fibonacci search

4. To perform different types of sortings on a given list
(i) Bubble sort (ii) Insertion sort (iii) Selection sort(iv) Merge sort

5. To perform different types of sortings on a given list
(i) Quick sort (ii) Shell sort (iii) Radix sort

6. To perform the following
(i) To convert the given infix expression to postfix expression
(ii) To evaluate the given postfix expression.

7. To perform various operations on graphs
(i) Vertex insertion. ii) Vertex deletion.
iii) Edge insertion. (iv)Edge deletion.
(v) Breadth First traversal.
(vi) Depth First traversal.

8. To implement dictionaries using hashing technique

9. To perform various operations on binary heap.

10. To perform various operations on Binary search tree.

11. To perform operations on AVL trees.

12. To perform various operations on B-tree.

MTCSTAIR 1. 8 ROBOTICS LAB

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 2**
Internal: 50 Marks **External: 50marks** **Total: 100Marks**

This Lab is intended to get familiarized with mechanical, electrical, and electronics structures of different types of robots for monitoring, controlling and developing applications like pick and place, swapping, e.t.c., by either stand alone controller in the robot structure or interfacing to PC.

1. Programming a simple Robot on Wheels.
2. Programming a Walking Robot.
3. Experiments based on Bipedal Robot.
4. Experiments based on Humanoid Robot-ROOBONOVA.
5. Pick and Place Application Programming with 4 DOF Robot Arm by Interfacing to PC.
6. Swap Application Programming with 4 DOF Robot Arm by Interfacing to PC.
7. Pick and Place Application Programming with 5 DOF Robot Arm by Interfacing to PC.
8. Swap Application Programming with 5 DOF Robot Arm by Interfacing to PC.
9. Pick and Place Application Programming with 6 DOF Robot Arm by Interfacing to PC.
10. Swap Application Programming with 6 DOF Robot Arm by Interfacing to PC.

REQUIRED MATERIALS

Mechanical Tools with Tool Box,, IBM Compatible PCs- 10 No,..

Interface Cables for Robot Structures.

Robot Platform.

Walking Robot structure with Controller.

BRAT Kit for Bipedal Robot.

Simple Humanoid Robot-ROBONOVA-I.

5 DOF Robot Arm with Accessories.

6 DOF Robot Arm with Accessories.

Detailed Syllabus for M.Tech Second Semester

II SEMESTER

Code	Name of the subject	Periods/week Theory	Lab	Max. Marks Ext.	Int.	Total	Credits
MTCST2.1	Artificial Intelligence	3	-	70	30	100	4
MTCSTAIR2.2	Expert Systems	3	-	70	30	100	4
MTCSTAIR2.3	Advanced Robotics	3	-	70	30	100	4
MTCST2.4	Data Warehousing & Mining	3	-	70	30	100	4
MTCSTAIR2.5	Elective III	3	-	70	30	100	4
MTCSTAIR2.6	Elective IV	3	-	70	30	100	4
MTCST2.7	Data ware housing & Mining Lab	-	3	50	50	100	2
MTCSTAIR2.8	AI & Expert Systems Lab	-	3	50	50	100	2
MTCST2.9	Seminar	-	-	-	100	100	2
	Total	18	6	520`	380	900	30

Elective III: Big Data Analysis/ Computer Vision/ Semantic Web/Database Security

Elective IV: Neural Networks& Fuzzy Systems/ Image Processing/ /Machine Learning

MTCST 2.1 Artificial Intelligence

Common for M.Tech (CST, CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. Introduction: Artificial Intelligence, AI Problems, AI Techniques, The Level of the Model, Criteria For Success. Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs, Un-Informed Search, BFS, DFS; Heuristic Search Techniques: Generate-And- Test, Hill Climbing, Best-First Search, A^* Algorithm, Problem Reduction, AO^* Algorithm, Constraint Satisfaction, Means-Ends Analysis.

2. Knowledge Representation: Procedural Vs Declarative Knowledge, Representations & Approaches to Knowledge Representation, Forward Vs Backward Reasoning, Matching Techniques, Partial Matching, Fuzzy Matching Algorithms and RETE Matching Algorithms; Logic Based Programming- AI Programming languages: Overview of LISP, Search Strategies in LISP, Pattern matching in LISP , An Expert system Shell in LISP, Over view of Prolog, Production System using Prolog

3. Symbolic Logic: Propositional Logic, First Order Predicate Logic: Representing Instance and is-a Relationships, Computable Functions and Predicates, Syntax & Semantics of FOPL, Normal Forms, Unification &Resolution, Representation Using Rules, Natural Deduction; Structured Representations of Knowledge: Semantic Nets, Partitioned Semantic Nets, Frames, Conceptual Dependency, Conceptual Graphs, Scripts, CYC;.

4. Reasoning under Uncertainty: Introduction to Non-Monotonic Reasoning, Truth Maintenance Systems, Logics for Non-Monotonic Reasoning, Model and Temporal Logics; Statistical Reasoning: Bayes Theorem, Certainty Factors and Rule-Based Systems, Bayesian Probabilistic Inference, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic: Crisp Sets ,Fuzzy Sets, Fuzzy Logic Control, Fuzzy Inferences & Fuzzy Systems.

5. Experts Systems: Overview of an Expert System, Structure of an Expert Systems, Different Types of Expert Systems- Rule Based, Model Based, Case Based and Hybrid Expert Systems, Knowledge Acquisition and Validation Techniques, Black Board Architecture, Knowledge Building System Tools, Expert System Shells, Fuzzy Expert systems.

6. Machine Learning: Knowledge and Learning, Learning by Advise, Examples, Learning in problem Solving, Symbol Based Learning, Explanation Based Learning, Version Space, ID3 Decision Based Induction Algorithm, Unsupervised Learning, Reinforcement Learning, Supervised Learning: Perceptron Learning, Back propagation Learning, Competitive Learning, Hebbian Learning.

7. Natural Language Processing: Role of Knowledge in Language Understanding, Approaches Natural Language Understanding, Steps in The Natural Language Processing, Syntactic Processing and Augmented Transition Nets, Semantic Analysis, NLP Understanding Systems; Planning: Components of a Planning System, Goal Stack Planning, Hierarchical Planning, Reactive Systems

Text Book:

1. Artificial Intelligence, George F Luger, Pearson Education Publications

2. Artificial Intelligence, Elaine Rich and Knight, Mcgraw-Hill Publications

References:

1. Introduction To Artificial Intelligence & Expert Systems, Patterson, PHI

2. Multi Agent systems- a modern approach to Distributed Artificial intelligence, Weiss.G, MIT Press.

3. Artificial Intelligence : A modern Approach, Russell and Norvig, Printice Hall

MTCSTAIR 2.2 EXPERT SYSTEMS

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction:** Introduction to Expert System, Definitions, Importance of Expert System, Charactestic features of Expert System, Applications of Expert System, Different ategories of Expert Systems, Rule Based System Archicture, Nural Network Archicture

2. **Knowledge Represention:** Components of a Knowledge in Expert system**,**OAV Triplets, Sementic Networks, Frams Represention via Logic Statements, Production Systems, Clause, Properties Rule properties, Rule Conversions, Multiple Conclusions,Nural Networks via Rule Based System

3. Knowledge Acqusition: Introduction Knowledge Acqusition and domain Expert, Selection of the domain, Selection of the Knowledge Engineers, Selection of the Expert, Meetings and Plans, Orgnization of Meetings,Documentation, Multiple domain Experts, Knowledge Acqisition -An Example, Knowledge Acquisition using Rule induction, Generating Rules from Trees, ID3 algorithm for Rule Generation

4. **Design of Expert System:**Introduction,Selecting the appropriate Probblem,Stateges in the Developing Expert System, Errors in Development stages, Software Engineering and Expert Systems,The Expert System Life Cycle, Expert System Design Examples- Certainty factors,Decission tress

5. **Inference Engine:** Inference Engine, Insight of Inference Engine, Search Strategies, Forward Chaining Algorithm,Algorithms for forward Chaining- Baseline Version, Backword Chaining Algorithm, Algorithms for Back word Chaining-Baseline Version, Mixed Modes of Chaining, Work sheets for Forward and Back word Chaining

6. Reasoning Under Uncertainity: Uncertainty,Types of Error,Error and Induction,Classic Probability,Temporal Reasioning and Morcov Chines,TMS,Fuzzy Logic and Natural Languages computations,Probabilistic Reasioning, probabilistic Networks,Bayesian Networks.Use of Probabilty and Fuzzy logic in Expert System, Rule Induction by Machine Learning

7. **Software Tools and Architectures:** Overview of Expert System Tools, Expert System Shells,Multiple Paradigm Environments,Absract architectures, Potential Implementation Problems, Selecting a Software Tool, Implentation Mechanism of tools, Black Board Architecture, Reasoning under uncertainity andTruth Maintance Systems

8. **Case-study :**A case-study on Financial planning Expert System, Sale Expert system, DENDRAL and MYCIN

Text Books:

1. Expert System principals and Programming-Giarratano.Rilev.2003
2. Introducion to Expert SystemsV-James P.Iginizo.Mc.Graw-Hill.inc
3. Introduction to Expert Systems Peter Jackson, Addison Wesley Publishing Company

References:

1. Introduction to artificial Intelligence & Expert System- Pan W.patterson.PHI
2. A Comprehensive Guide to AI and Expert systems, R.I.Levine D.E. Drang, Barry Edelson

MTCSTAIR 2.3 ADVANCED ROBOTICS

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. CONTROL SYSTEMS AND COMPONENTS:

Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components, Power Transmission Systems, Robot Joint Control Design.

2. ROBOT END EFFECTORS

Types, Mechanical Grippers and Other types, Tools as End Effectors, The Robot/End Effector Interface, Considerations in Gripper Selection and Design

3. MACHINE VISION

Introduction, The Sensing and Digitizing function, Image processing and Analysis,Trainig and Vision Systems, Robotic Applications

4. ROBOT PROGRAMMING

Programming methods, Robot program as a path in space,Motion Interpolation, WAIT,SGNAL,DELAY Commands, Branching

5. ROBOT LANGUAGES

The Textual Robot languages, Generations of Robot programming languages, Robot language Structures, Constants, Variables, and other data Objects, Motion Commands, program Control and Subroutines

6. ROBOT APPLICATIONS IN MANUFCATURING: Material Transfer And Machine Loading / Unloading, An Approach for Implementing Robotics

7. SOCIAL ISSUES and FUTURE OF ROBOTICS

Social and Labor issues, Robotics Technology of the future.

8. FUTURE APPLICATIONS: Characteristics of Future Robot Tasks, Future manufacturing Applications, Hazardous and Inaccessible Nonmanufacturing Environments

TEXT BOOK: Mikell P. Groover , Mitchell Weiss , Roger N. Nagel , Nicholas G. Odrey Industrial Robotics: Technology, Programming, and Applications , 1st edition, McGraw-Hill International Edition, 1986

REFERENCE BOOK: K.S.Fu, R.C Gonzalez, C.S.G.Lee , ROBOTICS , Control, Sensing , Vision and Intelligence , 1st edition, McGraw-Hill International Edition, 1987

MTCST 2.4 Data Warehousing & Mining

Common for M. Tech (CST, CSTAIR, BTMTSE)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction to Data Mining:** Evolution of I T into DBMS, Motivation and importance of Data Warehousing and Data Mining, Kinds of Patterns, Technologies, Basic Data Analytics: Data Objects and Attributes Types, Statistical Descriptions of Data, Data Visualization, Estimating Data Similarity and Dissimilarity, Major Issues in Data Mining., Data Mining Applications

2. **Data Warehouse and OLAP Technology:** Basic Concepts of Data warehouse, Data Modeling using Cubes and OLAP, DWH Design and usage, Implementation using Data Cubes and OLAPs, Data Generalization with AOI.

3. **Data Mining Primitives & Data Cubes:** Data Mining Primitives, Data Mining Tasks, Data Mining Query Language, Designing Graphical user Interfaces based on a Data Mining Query language, Preliminary Concepts of Data Cube Computation, Data Cube Computation Methods: Multi-way Array Aggregation for Full Cube, BUC Computing for Iceberg Cubes, Star-Cubing Using Dynamic Star-Tree Structure, Pre-computing Shell Fragments for Fast High-Dimensional OLAPs.

4. **Data Mining Concept Description:** Data Preprocessing: Pre-processing the Data, Data Cleaning, Data Integration, Data Reduction, Data Transformation, Discretization and Concept Hierarchy Generation; Data Architectures of Data Mining Systems; Characterization and Comparison, Concept Description, Data Generalization and Summarization; Analytical Characterization: Analysis of Attribute Relevance, Mining Class Comparisons, Discriminating between Different Classes, Mining Descriptive & Statistical Measures in Large Databases.

5. **Mining Frequent Patterns Based on Associations and Correlations:** Basic Concepts, Frequent Itemset Mining Methods: Apriori Algorithm, Association Rule Generation, Improvements to A Priori, FP-Growth Approach, Mining Frequent Patterns using Vertical Data Formats, Mining Closed and Max Patterns, Pattern Evaluation Methods

6. **Classification:** Basic Concepts, Decision Tree Induction, Bayes Classification, Rule-Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy Advanced Methods: Classification by Back Propagation, SVM, Associative Classification, Lazy Learning, Fuzzy Sets, Rough Sets, Genetic Algorithms, Multiclass Classification, Semi-Supervised Classification

7. **Cluster Analysis:** Basic Concepts, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Evaluation of Clustering Solutions

Text Book:

1. Data Mining- Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei – Morgan Kaufmann publishers –---3rd edition

References:

1. Data Mining Techniques, A.K.Pujari, University Press Data mining concepts by Tan, Steinbech, and Vipin Kumar - Pearson Edu publishers
2. Data Mining –Introductory and Advanced by Margarett Dunham -- Pearson Education publishers
3. Data Warehousing for Real –world by Sam Annahory-- Pearson Education publishers

MTCSTAIR 2.5 ELECTIVE III

NEURAL NETWORKS & FUZZY SYSTEMS

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Neural Networks and Fuzzy Systems:** Neural and Fuzzy Machine Intelligence, Fuzziness as Multivalence, The Dynamical- Systems Approach to Machine Intelligence, Intelligent Behavior as Adaptive Model- Free Estimation

2. **Neural Dynamics I:** Activations and Signals: Neurons as Functions, Signal Monotonicity, Biological Activations and Signals, Neuron Fields, Neuronal Dynamical Systems, Common Signal Functions, Pulse-Coded Signal Functions.

3. **Neuronal Dynamics II:** Activation Models: Neuronal Dynamical Systems, Additive Neuronal Dynamics, Additive Neuronal Feedback, Additive Bivalent Models, BAM Connection Matrices, Additive Dynamic and the Noise-Saturation Dilemma, General Neuronal Activations: Cohen-Grossberg and Multiplicative Models.

4. **Synaptic Dynamics I:** Unsupervised Learning: Learning as Encoding, Change, and Quantization, Four Unsupervised Learning Laws, Probability Spaces and Random Processes, Stochastic Unsupervised Learning and Stochastic Equilibrium, Signal Hebbian Learning, Competitive Learning, Differential Hebbian Learning, Differential Competitive Leering.

5. **Synaptic Dynamics II:** Supervised Learning: Supervised Function Estimation, Supervised Learning as Operant Conditioning, Supervised Learning as Stochastic Pattern Learning with known Class Memberships, Supervised Learning as stochastic Approximation, The Back propagation Algorithm.

6. **Fuzziness Versus Probability:** Fuzzy Sets and Systems, Fuzziness in a Probabilistic World, Randomness vs. Ambiguity: Whether vs. How much, The Universe as a Fuzzy Set, The Geometry of Fuzzy Set, The Geometry of Fuzzy Sets: Sets as Points. The Fuzzy Entropy Theorem, The Subset hood theorem. The Entropy-Subset hood Theorem.

7. **Fuzzy Associative Memories:** Fuzzy Systems as Between-Cube Mappings, Fuzzy and Neural Function Estimators, Fuzzy Hebb FAMs, Adaptive FAMs: Product-Space Clustering in FAM Cells.

Text Book:

Neural Networks & Fuzzy Systems, Bark Kosko, PHI

References:

1. Neural Network Design, Hagan, Demuth and Beale, Vikas Publishing House
2. Fundamentals of Artificial Neural Networks, Mohamad H Hassoum. PHI
3. Fuzzy Set Theory & its Applica tion, H.J. Zimmerman Allied Published Ltd.

MTCSTAIR2.5 Elective III Big Data Analytics

Common for M. TECH (CST, IT,CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction:**, Velocity, Variety, Veracity; Drivers for Big Data, Sophisticated Consumers, Automation, Monetization, Big Data Analytics Applications: Social Media Command Center, Product Knowledge Hub, Infrastructure and Operations Studies, Product Selection, Design and Engineering, Location-Based Services, Online Advertising, Risk Management

2. **Architecture Components:** Massively Parallel Processing (MPP) Platforms, Unstructured Data Analytics and Reporting: Search and Count, Context-Sensitive and Domain-Specific Searches, Categories and Ontology, Qualitative Comparisons, Data Privacy Protection, Real-Time Adaptive Analytics and Decision Engines

3. **Advanced Analytics Platform:** Real-Time Architecture for Conversations, Orchestration and Synthesis Using Analytics Engines, Entity Resolution, Model Management, .Discovery Using Data at Rest, Integration Strategies

4. **Implementation of Big Data Analytics:** Revolutionary, Evolutionary, or Hybrid, Big Data Governance, Integrating Big Data with MDM, Evolving Maturity Levels

5. **Map-Reduce and the New Software Stack**: Distributed File Systems .Physical Organization of Compute Nodes, Large-Scale File-System Organization, Map-Reduce features: Map Tasks, Grouping by Key, Reduce Tasks, Combiners, Map-Reduce Execution, Coping With Node Failures, Algorithms Using Map-Reduce for Matrix multiplication, Relational Algebra operations, Workflow Systems, Recursive Extensions to Map-Reduce,

6. **Communication Cost Models**, Complexity Theory for Map-Reduce, Reducer Size and Replication Rate, Graph Model and Mapping Schemas, Lower Bounds on Replication Rate

7. **Mining Data Streams**: Stream Data Mode l and Management Stream Source, Stream Queries, and issues, Sampling Data in a Stream , Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in a Window, Decaying Windows

8. **Link Analysis**: PageRanking in web search engines, Efficient Computation of PageRank using Map-Reduce and other approaches, Topic-Sensitive PageRank , Link Spam, Hubs and Authorities

Text Books:

1. Big Data Analytics:Disruptive Technologies for Changing the Game, *Dr. Arvind Sathi,,* First Edition
October 2012, IBM Corporation

2. Mining of Massive Datasets, Anand Rajarama, Jure Leskovec, Jeffrey D. Ullman.E-book, 2013

References:

1. Big Data Imperatives, Soumendra Mohanty, Madhu Jagadeesh, Harsha Srivatsa, Apress, e-book of 2012

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MTCSTAIR 2.5 Elective III Semantic Web
Common for M.Tech(CST,CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction to Semantic Web:** Introduction, Semantic Web, URI, RDF, Ontologies, Inferences, DAML, Semantic Web Languages, Semantic Annotation, Classification, Information Extraction, Ontology Assignment, XML, Syntax of XML,XML Schema, Semantic Web Applications to E-Commerce, E-Government and E-Banking, Semantic Web in Life Sciences, RIF Applications.

2. **Semantic Web Structure:** Semantic Web Layers Architecture, Different Layers, Match Making, Multi Information Retrieving, Digital Signature, Semantic Memory, Semantic Web Enabled Service Oriented Architecture(SESA), SESA Services, SESA Middle Ware.

3. **Resource Descriptive Languages RDF:** Introduction to RDF, Syntax of RDF, Advanced Feature,Simple Ontologies in RDF Schema, Encoding Special Data Structures, Semantics Model Theoritic Sentics for RDFs, Syntactic Reasoning with Deduction Rules Syntactic Limits of RDFs,

4. **Web Ontology Languages:** OWL Syntax, OWL Species, OWL2 Standards, OWL Formal Semantics, Description Logics, Model Theoretic Semantics of OWL, SWRL, Semantic Web Rules, Languages, Syntax of SWRL, Rules and Safety, Implementation & Applications.

5. **Ontology Engineering:** Requirement Analysis, Ontology Knowledge Creation, Ontologies and Rules: Definition of a Rule, Datalog as First order Rule Language, Combining Rules With OWDL, Rule Interchanging Formats RIF, Quality Assurance of Ontologies, Modular Ontologies, Divide and Conquer, Software Tools.

6. **Ontology Query Languages:** Semantic Web Query Languages and Implementations, ROPS(RDF OWL Processing Systems),SWOPS(SWRL Ontology Processing System, Bench Marking Results, SPARQL, Query Languages for RDF, Conjunctive Queries for OWLDL.

7. **Semantic Web Mining:** Introduction, Concepts in Semantic Web Mining,XML, RDF & Web Data Mining, Ontologies and Web Data Mining,Agents in Web Data Mining, Web Mining and Semantic Web As a Data Base, semantic Interoperability and Web Mining Web Mining Vs Semantic Web Mining

Text Book:

1. Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph, CRC Press

References:

1. Web Data Mining and Applications in Business Intelligence and Counter Terrorism, Bavani Thuraisingham, CRC Press, June 2003
2. Implementing Semantic Web Services-The SESA Frame Work, D. Fensel;M.Kerrigan; M.Zaremba, Springer

3. Enabling Semantic Web Services- The Web Service Modeling Ontology, Fensel,D; Lausen,H;Pollers, ABruijn,J; Stollberg,M;Spriger.
4. A Semantic Web Primer, Paul Groth, Frank van Harmelen, Rinke Hoekstra, The MIT Press, 2012.
5. Programming the Semantic Web, Toby Segaran, Colin Evans, Jamie Taylor Oreilly Publications, 2009

MTCSTAIR2.5 Elective III Data Base Security

Common for M. TECH (CST, IT,CSTAIR, CSTBI)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction To Database Security**: Fundamental Data Security Requirements, Data Security Concerns, Compliance Mandates, Security Risks, Developing Enterprise Security Policy, Defining a Security Policy, Implementing a Security Policy, Techniques to Enforce Security

2. **Database Access Control**: User Authentication, Protecting Passwords, Creating Fixed Database Links, Encrypting Database Link Passwords, Using Database Links Without Credentials, Using Database Links And Changing Passwords, Auditing With Database Links, Restricting A Database Link With Views, Trust Management & Negotiation,

3. **Database Security Issues**: Database Security Basics, Security Checklist, Reducing Administrative Effort, Applying Security Patches, Default Security Settings, Secure Password Support, Enforcing Password Management, Protecting The Data Dictionary, System and Object Privileges, Secure Data Outsourcing, Security in Advanced Database Systems, Security in Data Warehousing and OLAP Systems, Managing Enterprise User Security

4. **Framework For Database Security,:** Security for Workflow Systems, Secure Semantic Web Services, Spatial Database Security, Security Reengineering, Strong Authentication, Single Sign-On, Public Key Infrastructure (PKI) Tools, Configuring SSL on the Server, Certificates, Using Kerberos for Authentication

5. **Database Security Solutions**: Maintaining Data Integrity, Protecting Data, Controlling Data Access, Combining Optional Security Features, Compliance Scanner, Policy Trends in Database Control, Watermarking: Copyright Protection, Trustworthy Record Retention and Recovery, Privacy-Preserving Data Mining & Data Publishing. Privacy in Location-Based Services

6. **Database Auditing :** Auditing Database Users, User Privileges And Objects: Monitoring for Suspicious Activity, Standard Database Auditing, Setting the AUDIT_TRAIL, Specifying Audit Options, Viewing Auditing Options, Auditing the SYSDBA Users, Audit to XML Files, Value-Based Auditing, Auditing DML Statements, Triggering Audit Events, Maintaining the Audit Trail

7. **Database Privileges And Roles**: Authorization, Privileges, Benefits of Roles, Using Proxy Authentication With Roles, Creating An Enterprise Role, Securing Objects and Application Roles, Data Masking Primitives And Routines, Privacy in Location- Based Services

8. **Data Encryption For Database Security**: Problems Solved by Encryption, Storing the Key in Database, Key Management by User, Application-Based Encryption, Cipher Block Modes , Hash and Message Authentication Code, Transparent Data Encryption (TDE) & File Encryption Methods.

Text Books

1. Database Security, S.Castano, M. Fugini, G. Martella,P. Samarati, Addision-Wesley
2. Database Security By Alfred Basta, Melissa Zgola, Cengage Publication, 2012

References

1. Database Security & Auditing By Hassan A Afyouni, Cengage Delmar Learning India Pvt, 2009
2. Handbook Of Database Security:Applications And Trends,Michael Gertz, Sushil Jajodia, Springer

MTCSTAIR2.6 Elective IV Computer Vision

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **FUNDAMENTALS OF IMAGE PROCESSING:** Image Acquisition, Definitions of Pixel, Gray Value, Sampling, Quantization, Histogram, Image Sliding, Image Stretching. Distance and Connectivity. Image Smoothening Operations - Mean, Median, Mode Filters. Edge Enhancement Filters - Directional Filters, Laplacian, Sobel, and Robert. Definition of Image Compression - Run Length Encoding Method, Contour Encoding Method. Definition of Segmentation - Pixel based method of segmentation.

2. **MORPHOLOGICAL OPERAT IONS:** Definition of Thresholding, A few techniques of thresholding. Importance of Binary Images. Erosion, Dilation, Opening, Closing, HIT -or -MISS Transformation, Thinning, Thickening, Skeletons, Pruning, Con vex hull. Extensions to Gray - Scale Images.Applications of Gray - Scale Morphology. Applications of Morphological Operations in Pattern Analysis.

3. **SHAPE REPRESENTATION AND DESCRIPTIONS (Part - 1):** Region Identification, Algorithms for Region Identification, Shape Representation and Description - Chain Codes, Geometric Border Representation - Boundary Length, Curvature, Bending Energy, Signature, Chord Distribution, Fourier Transforms of Boundaries, Boundary Description using Segment Sequences, B -Spline Representation, Shape invariants.

4. **SHAPE REPRESENTATION AND DESCRIPTION (Part - 2):** Region - Based Methods - Area - Algorithms for Calculation of Area. Euler's Number, Projections, Eccentricity, Elongatedness, Rectangularity, Direction, Compactness. Detailed Discussion on - Moments. Convex hull, Algorithms related to convex hull. Graph Representation - Algorithm for Skeleton, Algorithm for Graph Construction. Definitions of Region Decomposition, Region Neighborhood Graphs, Shape Classes.

5. **OBJECT RECOGNITION:** Knowledge Representation, Statistical Pattern Recognition, - Classification Principles, Classifier Setting, and Classifier Learning. Syntactic Pattern Recognition - Grammars, and Languages, Syntactic Analysis, Syntactic Classifier. Recognition as Graph Matching - Isomorphism, Related Algorithms. Similarity of Graphs.

6. **CLUSTER ANALYSIS:** Definition, Hierarchical Clustering, - Agglomerative Clustering Algorithms, Single - Linkage Algorithm, Complete Linkage Algorithm, Average - Linkage Algorithm, Ward's Method. Partitional Clustering - Definition, Forgy's Algorithm, K - Means Algorithm, Isodata Algorithm. Applications in Pattern Analysis.

7. **ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC IN PATTERN ANALYSIS:** Introduction to ANN, Architecture of ANN, Activation Functions, Training of ANN - Supervised, Unsupervised, Reinforced, McCulloch - Pitts Model, HEBBNET, ADELINE, and Application of ANN in Pattern Analysis. Definition and Brief Discussion about Fuzzy Logic, Fuzzy Sets. Application in Pattern Analysis.

Text Books :

1. Pattern R ecognition and Image Analysis, Earl Gose, Richard Johnsonbaugh, Steve Jost , PHI
2. Image Processing, Analysis and Machine Vision, Milan Sonka,Vaclav Hlavac, VIKAS

References:

Introduction to Artificial Neural Networks, S.N. Sivanandam, M. Paul Raj ,VIKAS

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MTCSTAIR 2.6 Elective IV Image Processing

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Fundamentals of Image Processing:** Image Acquisition, Image Model, Sampling, Quantization, Relationship between Pixels, Distance Measures, Connectivity, Image Geometry, Photographic Film. Histogram: Definition, Decision Of Contrast Basing On Histogram, Operations Basing on Histograms Like Image Stretching, Image Sliding, Image Classification. Definition and Algorithm of Histogram Equalization.

2. **Image Transforms** : A Detail Discussion On Fourier Transform, DFT,FFT, Properties WALSH TransForm , WFT, HADAMARD Transform, DCT

3. **Image Enhancement**:

a) Arithmetic and Logical Operations, Pixel or Point Operations, Size Operations,
b) Smoothing Filters-Mean, Median, Mode Filters – Comparative Study
c) Edge Enhancement Filters – Directorial Filters, Sobel, Laplacian, Robert, KIRSCH Homogeneity
d) & DIFF Filters, Prewitt Filter, Contrast Based Edge Enhancement Techniques – Comparative Study
e) Low Pass Filters, High Pass Filters, Sharpening Filters. – Comparative Study
f) Colour Fundamentals and Colour Models
g) Colour Image Processing.

4. **Image Enhancement**: Design of Low Pass, High Pass, EDGE Enhancement, Smoothening Filters in Frequency Domain. Butter Worth Filter, Homomorphic Filters in Frequency Domain Advantages of Filters in Frequency Domain, Comparative Study of Filters in Frequency, Domain and Spatial Domain.

5. **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. Brief Discussion on:- Image Compression Standards.

6. **Image Segmentatio**n: 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, Motion in Segmentation

7. **Morphology**: Dilation, Erosion, Opening, Closing, Hit-And-Miss Transform, Boundary Extraction, Region Filling, Connected Components, Thinning, Thickening, Skeletons , Pruning Extensions to Gray – Scale Images Application of Morphology in I.P

8. Image , Video & Multimedia Communications: Multi-scale and multi-orientation representation; Geometry and texture representation; Object based representation; Hierarchical representation; Sparse representation, Multimedia with image and video content; Multimedia event synchronization;

Text Book:

1. Digital Image Processing, Rafael C. Gonzalez And Richard E. Woods, Addision Wesley
Reference Books:
2. Fundamentals Of Electronic Image Processing By Arthyr – R – Weeks, Jr.(PHI)
3. Image Processing, Analysis, And Machine Vision By Milan Sonka Vaclan Halavac Roger Boyle, Vikas Publishing House.
4. Digital Image Processing, S. Jayaraman, S. Esakkirajan& T. Veera Kumar, TMH
5. Fundamentals of Digital Image Processing, Chris Solomon, Tobi Breckon, Wiley-Blackwell

MTCST AI 2.6 Elective II Machine Learning

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 4**
Internal: 30 Marks **External: 70 Marks** **Total: 100 Marks**

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1. **Introduction:** Introduction to Machine Learning, learning task- illustration, Approaches to Machine Learning, Machine Learning algorithms- Theory, Experiment in biology and Psychology.

2. **Concept Learning:** Introduction, Concept Learning Task- Notation, Concept Learning Search, Version spaces, Candidate Elimination Algorithm, Inductive Bias, Biased hypothesis Space, Unbiased Learner, Bias-free Learning, Active queries, Mistake bound/PAC model – basic results. Overview of issues regarding data sources, success criteria

3. **Decision Tree Learning:** Decision Tree Representation, Basic decision Tree Learning, Inductive bias in Decision tree Learning, Issues in Decision Tree Learning, Minimum Description Length Principle, Occam's razor, Learning with active queries

4. **Neural Network Learning:** Neural Network Representation, Problems for Neural Network Learning, Perceptions and gradient descent, Multi Layer Network and Back propagation Algorithm, Illustrative Example of Back Propagation Algorithm- Face Recognition, Advanced Topics in ANN.

5. **Bayesian Approaches:** Basics of Bayes Theorem and Concept Learning, Expectation Maximization, Minimum Description Length Principle, Navie Bayes Classifier, Bayesian Belief Networks, EM Algorithm, K-Means Algorithm, Hidden Markov Models Instance-Based Techniques; Lazy vs. eager generalization, k nearest neighbor, Locally Weight Representation, Case-based Reasoning

6. **Analytical Learning:** Inductive and Analytical Learning problems, Learning with perfect Domain Theory, Explanation Based Learning, Inductive Bias in EBL, Search Control Knowledge with EBL, Inductive- Analytical Approaches to Learning, Using prior Knowledge for Initialize the Hypothesis, and Altering Search objective, FOCL Algorithm.

7. **Genetic Algorithms:** Representation of Hypothesis as GA,, Genetic Operators, Fitness function and Selection, Hypothesis Space search, Genetic Programming, Models of Evolution and Learning, Parallelizing GA, Different search methods for induction

Text Books:

1. Machine Learning, Tom Mitchell , McGraw Hill, 1997
2. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani & Jerome Friedman, Springer Verlag, 2001

Reference Books:

3. Pattern Classification, Richard 0. Duda, Peter E. Hart and David G. Stork, John Wiley & Sons Inc., 2001
4. Neural Networks for Pattern Recognition, Chris Bishop, Oxford University Press, 1995

MTCST2.7 Data Warehousing & Mining LAB (common for M.Tech (CST, CSTAIR)

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 2**
Internal: 50 Marks **External: 50 Marks** **Total: 100 Marks**

Scope: Lab Experiments using R/Python/Java programming languages or software like Weka/ SYSTAT Tools

1. Demonstration of Preprocessing on some datasets eg. Student.aarf/ labor.aarf/Iris/ loan/ etc
2. Demonstration of Data Visualisation using Weka/ SYSTAT/ R programming language
3. Demonstration of Linear regression and non-linear regression model building using R
4. Demonstration of Association Rules extraction on Market basket data using apriori/ FP Algorithms
5. Demonstration of Classification Rule extraction a bench mark dataset using j48/ID3 Algorithm
6. Demonstration of Classification Rule Process on any datasets using Navie Bayes Algorithm
7. Demonstration of Classification Rule Process on any datasets using K-nearest Neighbor classification Algorithm
8. Demonstration of partitional Clustering on any datasets using K-means Algorithm
9. Demonstration of Clustering on any datasets using simple K-means algorithm
10. Demonstration of Clustering rules process on any datasets of images using DB Scan algorithm
11. Demonstration of Clustering rules process on any datasets using Birch Algorithm

MTCSTAIR2.8 Artificial Intelligence &Expert Systems Lab

Instruction: 3 Periods/week **Time: 3 Hours** **Credits: 2**

Internal: 50 Marks **External: 50 Marks** **Total: 100 Marks**

PART A

1. Implementation of DFS for water jug problem using LISP /PROLOG
2. Implementation of BFS for tic-tac-toe problem using LISP /PROLOG/Java
3. Implementation of TSP using heuristic approach using Java/LISP/Prolog
4. Implementation of Simulated Annealing Algorithm using LISP /PROLOG
5. Implementation of Hill-climbing to solve 8- Puzzle Problem
6. Implementation of Towers of Honoi Problem using LISP /PROLOG
7. Implementation of A* Algorithm using LISP /PROLOG
8. Implementation of Hill Climbing Algorithm using LISP /PROLOG
9. Implementation Expert System with forward chaining using JESS/ CLIPS
10. Implementation Expert System with backward chaining using RVD/PROLOG

Part B

Mini project on developing any Simple Expert Systems

1. A case-study on Financial planning Expert System,
2. Sale Expert system,
3. DENDRAL
4. MYCIN
5. Any Expert system of Student Choice

MTCST 2.9 SEMINAR ON ADVANCED TOPICS

Practical: 3 Periods /week **Internal Assessment Marks: 100** **Credits:2**

Purpose:
To enable a student to be familiar with Communication skills
Student is expected to Learn

a. How to Make a Presentation
 i. Verbal
 ii. Non Verbal
 iii. LCD based Power Point

b. How to write a report
 i. Abstract
 ii. Body
 iii. Conclusions
 iv. Executive Summary

c. Group Discussion
 i. Share the work with a group
 ii. Modularization of the work
 iii. Shareware Development

d. Communication
 i. Horizontal
 ii. Vertical

Students will be Given a Topic of Importance and are expected

A. To Present the Topic Verbally in 45 minutes + Question Answering
B. To Present the Topic as a Report in 50 Pages

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III SEMESTER

Common for final year M. Tech (CST, IT, CSTAIR, CSTBI, CSTCN) and 6year Integrated courses

Code	Name of the subject	Periods/week		Max. Marks		Total Credits
		Theory	Lab	Ext.	Int.	
MTCST3.1	Thesis Work Part 1		Grade		Grade	10

4. Candidates can do their thesis work within the department or in any industry/research organization for two semesters. In case of thesis done in an industry/research organization, one advisor (Guide) should be from the department and one advisor(CO-Guide) should be from the industry/research organization.
5. Thesis part I should be submitted at the end of final year 1st semester and it will be evaluated by a committee consisting of Chairman Board of Studies, Head of the Department and thesis guide.
6. Although credits are allotted for the thesis work they will not be taken for the calculation of CGPA.

VI YEAR II SEMESTER

Code	Name of the subject	Periods/week		Max. Marks		Total Credits
		Theory	Lab	Ext.	Int.	
MTCST4.1	Thesis Work Part 2		Grade		Grade	14

6. A publication of a paper on the thesis work in a National/International Conference proceedings with presentation certificate or a paper on the thesis work be communicated to a National/International Journal & accepted for publication for the submission of thesis at the end of final year is mandatory.
7. Final Thesis with Part I & Part II should be submitted at the end of final year and it will be evaluated by a committee consisting of Chairman Board of Studies, Head of the Department , External Examiner and thesis guide.
8. The candidate has to defend his thesis in a Viva-voce examination to be conducted by the above committee. The committee should submit a report, with signatures of all the members, candidate wise, with grade A-Excellent/ Grade B-Good/Grade C- fair/ Grade D- Reappear.
9. The external examiner shall be nominated by the Hon'ble Vice Chancellor as per the norms of the University.
10. Although credits are allotted for the thesis work they will not be taken for the calculation of CGPA.

GUIDELINES FOR PREPARING THE REPORT OF PROJECT WORK

1. ARRANGEMENT OF CONTENTS:

The sequence in which the project report material should be arranged and bound should be as follows:

1. Cover Page & Title Page
2. Bonafide Certificate
3. Abstract
4. Table of Contents
5. List of Tables
6. List of Figures
7. List of Symbols, Abbreviations and Nomenclature
8. Chapters
9. Appendices
10. References

The table and figures shall be introduced at appropriate places.

2. PAGE DIMENSION AND BINDING SPECIFICATIONS:

The dimension of the project report should be in A4 size. The project report should be bound using flexible cover of the thick white art paper. The cover should be **printed in black letters** and the text for printing should be identical.

3. PREPARATION FORMAT:

3.1 Cover Page & Title Page – A specimen copy of the Cover page & Title page of the project report are given in **Appendix 1.**

3.2 Bonafide Certificate – The Bonafide Certificate shall be in double line spacing using Font Style Times New Roman and Font Size 14, as per the format in **Appendix 2.** The certificate shall carry the supervisor's signature and shall be followed by the supervisor's name, academic designation (not any other responsibilities of administrative nature),department and full address of the institution where the supervisor has guided the student. The term **'SUPERVISOR'** must be typed in capital letters between the supervisor's name and academic designation.

3.3 Abstract – Abstract should be one page synopsis of the project report typed one and half line spacing, Font Style Times New Roman and Font Size 12.

3.4 Table of Contents – The table of contents should list all material following it as well as any material which precedes it. The title page and Bonafide Certificate will not find a place among the items listed in the Table of Contents but the page numbers of which are in lower case Roman letters. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents of the project report is given in **Appendix 3.**

3.5 List of Tables – The list should use exactly the same captions as they appear above the tables in the text. One and a half spacing should be adopted for typing the matter under this head.

3.6 List of Figures – The list should use exactly the same captions as they appear below the figures in the text. One and a half spacing should be adopted for typing the matter under this head.

3.7 List of Symbols, Abbreviations and Nomenclature – One and a half spacing should be adopted or typing the matter under this head. Standard symbols, abbreviations etc. should be used.

3.8 Chapters – The chapters may be broadly divided into 3 parts (i) Introductory chapter, (ii) Chapters developing the main theme of the project work (iii) and Conclusion. The main text will be divided in to several chapters and each chapter may be further divided into several divisions and sub-divisions.

- Each chapter should be given an appropriate title.
- Tables and figures in a chapter should be placed in the immediate vicinity of the reference
- where they are cited.
- Footnotes should be used sparingly. They should be typed single space and placed directly underneath in the very same page, which refers to the material they annotate.

3.9 Appendices –

- Appendices are provided to give supplementary information, which is included in the main text may serve as a distraction and cloud the central theme.
- Appendices should be numbered using Arabic numerals, e.g. Appendix 1, Appendix 2, etc. Appendices, Tables and References appearing in appendices should be numbered and referred to at appropriate places just as in the case of chapters.
- Appendices shall carry the title of the work reported and the same title shall be made in the contents page also.

3.10 List of References –The listing of references should be typed 4 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. The reference material should be listed in the alphabetical order of the first author. The name of the author/authors should be immediately followed by the year and other details .A typical illustrative list given below relates to the citation example quoted above.

REFERENCES:

1. Barnard, R.W. and Kellogg, C. (1980) Applications of Convolution Operators to Problems in Univalent Function Theory, Michigan Mach, J., Vol.27, pp.81–94.
2. Shin, K.G. and Mckay, N.D. (1984) Open Loop Minimum Time Control of Mechanical Manipulations and its Applications, Proc. Amer.Contr.Conf., San Diego, CA, pp. 1231-1236.

4. TYPING INSTRUCTIONS:

The impression on the typed copies should be black in color. One and a half spacing should be used for typing the general text. The general text shall be typed in the Font style Times New Roman and Font size 12.

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