ANDHRA UNIVERSITY:: VISAKHAPATNAM

M.Tech Computer Science & Technology with Specialization in Bioinformatics

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

I SEMESTER

Code	Name of the subject	Periods/week Theory	Lab	Max. Marks Ext.	Int.	Total	Credits
MTCST1.1	Mathematical Foundations of Computer Science	3	-	70	30	100	4
MTCST1.2	Data Structures & Algorithms	3	-	70	30	100	4
MTCST1.3	Adv Database Management Systems	3	-	70	30	100	4
MTCSTBI1.4	Fundamentals of Bioinformatics	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
MTCSTBI1.8	Bioinformatics 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 Theory	Lab	Max. Marks Ext.	Int.	Total	Credits
MTCST2.1	Artificial Intelligence	3	-	70	30	100	4
MTCSTBI2.2	Bioinformatics Algorithms	3	-	70	30	100	4
MTCSTBI2.3	Data Mining for Bioinformatics	3	-	70	30	100	4
MTCSTBI2.4	Computational Techniques for Bioinformatics	3	-	70	30	100	4
MTCSTBI2.5	Elective III	3	-	70	30	100	4
MTCSTBI2.6	Elective IV	3	-	70	30	100	
MTCSTBI2.7	Computational Biology Lab	-	3	50	50	100	2
MTCSTBI2.8	Perl Programming Lab	-	3	50	50	100	2
MTCST2.9	Seminar	-	-	-	100	100	2
	Total	18	6	520`	380	900	30

Elective III: Semantic Web/ Modeling of Protein Structures/ Big Data Analysis/Database Security

Elective IV: Genetic Algorithms/Geno-Informatics/Fuzzy Systems

III SEMESTER

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

Code	Name of the subject	Periods/week Theory	Lab	Max. Marks Ext.	Int.	Total 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	Lab	Max. Marks Ext.	Int.	Total 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 Bio-Informatics 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.

MTCSTBI1.4 FUNDAMENTALS OF BIOINFORMATICS

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

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1. Introduction:
Definitions, Sequencing, Biological sequence/structure, Genome Projects, Pattern recognition an prediction, Folding problem, Sequence Analysis, Homology and Analogy.

2**. Protein Information Resources**
Biological databases, Primary sequence databases, Protein Sequence databases, Secondary databases, Protein pattern databases, and Structure classification databases.

3**. Genome Information Resources**
DNA sequence databases, specialized genomic resources

4**. DNA Sequence analysis**
Importance of DNA analysis, Gene structure and DNA sequences, Features of DNA sequence analysis, EST (Expressed Sequence Tag) searches, Gene hunting, Profile of a cell, EST analysis, Effects of EST data on DNA databases.

5. **Pair wise alignment techniques**
Database searching, Alphabets and complexity, Algorithm and programs, Comparing two sequences, sub-sequences, Identity and similarity, The Dotplot, Local and global similarity, different alignment techniques, Dynamic Programming, Pair wise database searching.

6. **Multiple sequence alignment**
Definition and Goal, The consensus, computational complexity, Manual methods, Simultaneous methods, Progressive methods, Databases of Multiple alignments and searching

7. **Secondary database searching**
Importance and need of secondary database searches, secondary database structure and building a sequence search protocol .

8. **Analysis packages**
Analysis package structure, commercial databases, commercial software, comprehensive packages, packages specializing in DNA analysis, Intranet Packages, Internet Packages.

Text Books:
1. Introduction to Bioinformatics, by T K Attwood & D J Parry-Smith
Addison Wesley Longman
2. Bioinformatics- A Beginner's Guide by Jean-Michel Claveriw, Cerdric Notredame, WILEY dreamlech India Pvt. Ltd

Reference Books:
1. Introduction to Bioinformatics by M.Lesk OXFORD publishers (Indian Edition)

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 Books:

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 Books:

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.

Reference Books:

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 Books:

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.

Reference Books:

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 Books:

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

Reference Books:

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

Reference Books:

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 Books:

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**

Common with 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.

MTCSTBI1.8 **Bio-Informatics Lab**

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

Purpose: This lab provides exposure to various Bio-Informatics tools to demonstrate various theoretical concepts related to Bio-informatics. The students are expected to know about different databases available and techniques like sequence alignment.

List of Experiments:

1. **Introduction about different biological databases**
   Protein and Gene Sequence Databases (NCBI,DDBJ, EMBL, SWISS PROT,PIR)
   Structure Databases (MMDB,PDB,FSSP,CATH,SCOP)
   Pathway Databases (KEGG,BRENDA,METACYC,ECOCYC)
   Bolographic Databases (PUBMED,MEDLINE)
2. **Sequence Retrieval From Biological Databases**
3. **Gene Prediction Methods**
4. **Analysis Of Protein Sequence Using Expasy**
5. **Sequence Similarity Searching Of Nucleotide Sequences**
6. **Sequence Similarity Searching Of Protein Sequences**
7. **Multiple Sequence Alignment**
8. **Dynamic Programming Method-Local Alignment**
9. **Dynamic Programming Method-Global Alignment**

Reference Book

Lab Manual

Detailed Syllabus for M. Tech CSTBI Second Semester

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 Books:

1. Artificial Intelligence, George F Luger, Pearson Education Publications
2. Artificial Intelligence, Elaine Rich and Knight, Mcgraw-Hill Publications

Reference Books:

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

MTCSTBI 2.2 BIOINFORMATICS ALGORITHMS

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

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

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1. **String Matching:** Fundamental String Problem, Fundamental Preprocessing And First Algorithms Naive Method, Preprocessing Approach, Fundamental Preprocessing of The Pattern, Fundamental Preprocessing in Linear Time, Simplest Linear-Time Exact Matching Algorithm.

2. **Classical Methods Of Exact Matching:** Exact Matching Of Classical Comparison-Based Methods, Knuth-Morris-Pratt Algorithm, Real-Time String Matching Boyer-Moore Algorithm, Linear Time Bound for Boyer-Moore, Cole's Linear Worst-Case Bound for Boyer-Moore, Preprocessing for Knuth-Morris-Pratt, Exact Matching With a Set of Patterns, Applications of Exact Set Matching, Regular Expressions Pattern Matching.

3. **Suffix Trees :** Introduction, Basic Definitions, Examples, Anaive Algorithm to Build Suffix Trees, Linear-Time Construction of Suffix Trees**,** Ukkonen's Linear-Time Suffix Tree Algorithm, Weiner's Linear-Time Suffix Tree Algorithm, Mccreight's Suffix Tree Algorithm, Generalized Suffix Tree for a Set of Strings, Practical Implementation Issues.

4. **Applications Of Suffix Trees:** APL1 Exact String Matching, APL2: Suffix Trees And The Exact Set Matching Problem, APL5: Recognizing DNA Contamination, Introduction to Repetitive Structures in Molecular Strings , APL11: Finding All Maximal Repetitive Structures in Linear Time, Suffix Trees in Genome-Scale Projects, APL15: A Boyer-Moore Approach to Exact Set Matching, APL 16: Ziv-Lempel Data Compression, APL17: Minimum Length Encoding of DNA, Additional Applications.

5. **Inexact Matching:** Sequence Alignment, Dynamic Programming, (Sub) Sequence Comparison in Molecular Biology core String Edits, Alignments, Dynamic Programming, Edit Distance Between two Strings, Dynamic Programming Calculation of Edit Distance, Edit Graphs, Weighted Edit Distance, String Similarity, Local Alignment: Finding Substrings of High Similarity

6. **Multiple String Comparison:** Multiple String Comparison, Biological uses for Multiple String Comparison, Family and Super-family Representation, Multiple Sequence Comparison for Structural Inference, Computing Multiple String Alignments, Multiple Alignment with the Sum-Of-Pairs (SP), Objective Function, Multiple Alignment with Consensus Objective Functions, Multiple Alignment to Phylogenetic Tree, Bounded-Error Approximations, Common Multiple Alignment Methods.

7. **Sequence Databases:** Mother Lode Database Industry, Algorithmic Issues in Database Search, Real Sequence Database Search, FASTA, BLAST, RAM: Major Amino Acid Substitution Matrices, PROSITE, BLOCKS and BLOSUM, Additional Considerations for Database Searching.

8. **Maps, Mapping, Sequencing, and Superstrings:** DNA Mapping and Sequencing Problems, Mapping - Genome Project, Physical Versus Genetic Maps, Physical Mapping, STS-Content Mapping and Ordered Clone Libraries, Radiation-Hybrid Mapping, Fingerprinting for General Map Construction, Computing Tightest Layout, Map Alignment, Large-Scale Sequencing and Sequence Assembly, Directed Sequencing, Top-Down, Bottom-Up Sequencing using YACS, Shotgun DNA Sequencing, Sequence Assembly, , Shortest Superstring Problem, Sequencing By Hybridization.

Text Books:

1. Algorithms On Strings, Trees And Sequences: Computer Science And Computational Biology By Dan Gusfield, Cambridge University Press 1997.

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MTCST BI 2.3 DATA MINING FOR BIOINFORMATICS

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:** Introduction to 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, Introduction to Classification & Clustering

2. **Data Mining Concepts:** Pre-processing the Data, Data Cleaning, Data Integration, Data Reduction, Data Transformation, Discretization and Concept Hierarchy Generation; 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.

3. **Knowledge Discovery in Databases*:*** Transcription and Translation, Human Genome Project, Scientific Work Flows and Knowledge Discovery, Biological Data Storage and Analysis, the Curse of Dimensionality, Analysis of Data Using Large Databases, Challenges in Data Cleaning, Data Integration, Data Warehousing,

4. **Feature Selection and Extraction Strategies in Data Mining*:*** Over fitting, Data Transformation, Features and Relevance, Overview of Feature Selection, Filter Approaches for Feature Selection ,Feature Subset Selection Using Forward Selection, Other Nested Subset Selection Methods, Feature Construction and Extraction.

5. **Feature Interpretation for Biological Learning*:*** Introduction, Normalization Techniques for Gene Expression Analysis, Data preprocessing of Mass Spectrometry Data, Techniques for MS Data Analysis, Data Preprocessing for Genomic Sequence Data, Ontology's in Bioinformatics.

6. **Clustering Techniques in Bioinformatics*:*** Clustering in Bioinformatics, Clustering Techniques, Applications of Distance-Based Clustering in Bioinformatics, Implementation of k-Means in WEKA, Hierarchical Clustering ,Implementation of Hierarchical Clustering, Self-Organizing Maps Clustering, Fuzzy Clustering, Implementation of Expectation Maximization Algorithm.

7. **Advanced Clustering Techniques*:*** Graph-Based Clustering, Measures for Identifying Clusters, Determining a Split in the Graph, Graph-Based Algorithms, Application of Graph-Based Clustering in Bioinformatics ,Kernel-Based Clustering, Application of Kernel Clustering in Bioinformatics, Model-Based Clustering for Gene Expression Data, Relevant Number of Genes, Higher-Order Mining, Conclusion

8. **Classification Techniques in Bioinformatics*:*** Supervised Learning in Bioinformatics, Support Vector Machines (SVMs), Bayesian Approaches, Decision Trees, Ensemble Approaches, Computational Challenges of Supervised Learning; Validation and Benchmarking, Performance Evaluation Techniques, Classifier Validation, Performance Measures, Cluster Validation Techniques.

Text books

1. Data Mining for Bio-Informatics , Sumeet Dua, Pradeep chowriappa, CRC Press, Taylor & Francies Group, LLC 2013.
2. Data Mining- Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei –Morgan Kaufmann publishers –--3rd edition

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MTCSTBI 2.4 COMPUTATIONAL TECHNIQUES FOR BIOINFORMATICS

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

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1. **Introduction:** Basics of Gene expression - Definition - gene expression studies, gene expression patterns - Applications of gene expression studies - Microarrays – definition, discovery, technique, making microarrays, spotted microarrays, in situ synthesized oligonucleotide arrays, inkjet array synthesis, affymetrix techniques, DNA Chip technology -Photolithography, spot quality, sample preparation and labeling, washing, image acquisition - Sequencing by Hybridization Arrays.

2. **DNA Microarrays:** DNA Mass Array ™ Technology - Printing DNA Microarrays -Types of Microarrays - Designing a microarray experiment; Carbohydrate Microarrays: Carbohydrate microarrays - Carbohydrate sources - Synthesis of oligosaccharides - Isolation of oligosaccharides from natural sources- Arrays of monosaccharides and disaccharides, Arrays of polysaccharides, Arrays of oligosaccharides - Perspectives , .

3. **Databases for Microarrays:** Bioinformatics in Arrays - Databases and tools for microarrays - Bioconductor, expression profiler, EST databases - Assessing levels of gene expression using EST's, TIGR gene indices, STACK, SAGE, CGAP, Xprofiler, ARRAY DB,

4. **Tools for Microarrays:** Cluster, treeview, Scanalyze, genecluster, informatics aspects of microarray production - MGED and gene-ontology, description of MIAME (Minimum Information About a Microarray Experiment), Business Aspects of Biochip Technologies - Microarray Technology in Treating Disease. DNA microarray analysis - clustering - immunological applications

5. **Sampling Theory:** Methods of sampling – simple random sampling, stratified and systematic sampling, Concept of sampling distributions and standard error, Test of Significance, Large and Small sample Tests, Correlation and Regression Analysis, Multiple regression analysis, Principal Component analysis, Canonical Correlation analysis, Factor Analysis, Descriminant Analysis, Cluster Analysis

6. **Markov Chain Models:** Definition, Classification, Markov Chain, Transition Probability Matrix, chapman Kolmogrov theorem, Classification of states and chains, Poisson Process, Postulates, Properties. Hidden Markov Models Basic Algorithms, Viterbi Algorithm, Estimation, Forward and Backward Algorithm, Applications - Multiple Sequence Alignment, Pfam and Gene finding.

7. **Prediction :** Prediction of cross hybridization to related genes, thermodynamics of nucleic acid duplexes, prediction of Tm probe secondary structure - Analysis of relationships between genes, tissues or treatments - similarity of gene or sample profiles – dimensionality reduction, principal component analysis, hierarchial clustering, machine learning methods for cluster analysis, classification of tissues and samples – validation.

8. **Image Processing :** Image processing, feature extraction, identifying positions of features - Normalization – data cleaning and transformation, within array normalization, between array normalization, measuring and quantifying microarray variability – variability between replicate features on an array, variability between hybridizations to different arrays - Analysis of differentially expressed genes - significance analysis of microarrays.

Text Books:

1. Bioinformatics: Sequences and Genome Analyses David W. Mount, Cold Spring Harbor Laboratory Press, 2000.
2. Microarray Bioinformatics, Dov Stekel, Cambridge, 2003.

Reference Books:

3. A Biologist's Guide to Analysis of DNA Microarray Data, Steen Knudsen, , John Wiley & Sons, 2nd Edition 2004.

4. Bioinformatics: A Practical Guide to the Analysis of Gene and Proteins, Andreas D Baxevanis and BF Francis Ouelette, Wiley-Interscience, 1998.
5. Probability, "Statistics and Random Process", Veerarajan T, Tata Mcgraw Hill, 4th Edition, 2008.
6. Probability & Statistics for Engineers & Scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Prentice Hall, 2006. 8th Edition,

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MTCSTBI 2.5 Elective III Modeling of Protein Structures

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 Protein Structure- Overview of DNA, RNA, Protein Sequence, Amino Acids, Levels of Protein Structures- Primary, Secondary, Tertiary and Quaternary Protein Structure, Prediction Methods.

2. **Biological Databases:** Sequence Databases, Mapping Databases, Information Retreival from Biological Databases, Genomic Databases.

3. **Statistical Methods :** Chou and Fasman, Garnier-Osguthorpe-Robson, Stereochemical Method of Lim and Neural Network Method, etc. Fold Recognition and Threading Methods,

4. **Mathematical Methods:** Profiles, Motifs – Regular Expressions, Position Specific Scoring Matrices, Repeat Finding and pattern Recognition .

5. **Classification:** Classification of Three Dimensional Structures of Proteins, Prediction of Structural Classes, Motifs, Folds, Domains, Classification of Three Dimensional Structures in Brookhaven Protein Data Bank (HSSP, SCOP, FSSP, CATH).

6. **Protein Structure Prediction:** Structural Alignment Methods, Deli Algorithm, Homology Modeling , Dynamic Programming, Molecular Simulation, Rational Drug design and Docking

7. **Inferring Methods:** Pair wise Sequence Alignment, Assessment of Similarity in Pair wise sequence alignment, Creation and Analysis of Protein Multiple sequence alignments, Sequence Assembly and Finishing Methods, Polygenetic Analysis.

8. **Computational Approaches:** Computational Approaches in Comparative Genomics-Andreas D. Baxevanis Approach, John Quackerbush Approach using DNA Microarrays to Assay Gene Expression.

Text Books:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Baxevanis, A.D. and Francis Ouellette, B.F Second Edition, Wiley-2004

Reference Books:

2. Proteome Research: New Frontiers in Functional Genomics, Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors), Springer Verlag Berlin Heidelberg- 1997
3. Fundamentals of Molecular Evolution, Graur, D. and Li, W-H, Sinauer Ass., USA.-2000
4. Mastering Perl for Bioinformatics, Tisdall, D., O'Reilly, 2003
5. Sequence - Evolution – Function- Computational Approaches in Comparative Genomics, Eugene V Koonin and Michael Y Galperin, Kluwer Academic-Boston, ; 2003, ISBN-10: 1-40207-274-0

MTCSTBI 2.5 **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

Reference Books:

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

MTCSTBI 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 Books:

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

Reference Books:

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

MTCSTBI 2.5 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

Reference Books

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

MTCSTBI 2.6 Elective IV GENETIC ALGORITHMS

Common with M. Tech (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 Genetic Algorithms, Simple Genetic algorithm, Applications of genetic algorithms Genetic Algorithms in Scientific models, Evolving computer programs, data analysis & prediction, evolving neural networks, Basics of Neural Networks , Fuzzy Systems.

2. Theoretical Foundation of genetic algorithm: Modeling interaction between learning & evolution, modeling sexual selection, measuring evolutionary activity. Schemas & Two-Armed and k-armed problem, royal roads, exact mathematical models of simple genetic algorithms, Statistical- Mechanics Approaches.

3. Basics of Genetic Algorithms: Biological Basis for Genetic Algorithms, Genetic Operators, Creation of offspring, Encoding, Fitness function, Reproduction-Roulette- wheel selection, Boltzmann Selection, Tournament selection, Rank Selection, Steady state selection.

4. Computer Implementation of Genetic Algorithm: Data structures, Reproduction, crossover & mutation, mapping objective functions to fitness form, fitness scaling, coding, a multiparameter, mapped, fixed point coding, Discretization and constraints.

5. Genetic Modeling: Inheritance operators, Cross over, Inversion and Deletion, Mutation Operators, Bitwise Operators in GA, Generalization Cycle, Convergence of GA, Multi level optimization, Differences Between GA and Traditional Methods, Real life Problems, Advances in GA.

6. Applications of Genetic Algorithms: Composite Laminators, Constrained Optimization, Risk of genetic algorithms, De Jong & function optimization, Improvement in basic techniques, current application of genetic algorithms

7. Advanced Operators & Techniques in genetic search Dominance, duplicity, & abeyance, other reordering operators, other micro operators, Niche & speciation, multi objective optimization, knowledge based techniques, genetic algorithms & parallel processors.

8. Fuzzy Logic Controlled Genetic Algorithms: Soft Computing Tools, Problem Descriptions of Optimal Design, Fuzzy Constraints, GA in Fuzzy Logic Controller Design, (Fuzzy Logic Controller- Genetic Algorithm)FLC-GA Based Structural Optimization and Applications.

TEXT BOOKS:

1. David E. Goldberg, "Genetic algorithms in search, optimization & Machine Learning" Pearson Education, 2006

REFERENCE BOOKS:

1. An introduction to genetic algorithms, Melanle Mitchell, Prentice Hall India, 2002.
2. The simple genetic algorithm foundations and theory, Michael D. Vose, Prentice H
3. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekharan, GA Vijayalakhmi Pai, PHI

MTCSTBI 2.6 Elective IV GENO INFORMATICS

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 Genomics, Computational Approaches in Comparative Genomics, Genome sequence, Functional genomics- Similarity, Homology, Divergence and Convergence of genomes, Patterns and Mechanisms in Genome Evolution**,**

2. **Information Sources for Genomics:** General Purpose Sequence Databases, Protein Sequence Motifs and Domain Databases, Protein Structure Databases, Specialized Genomics Databases, Organism-specific Databases, Taxonomy, Protein Interactions, and Other Databases, PubMed

3. **Principles and Methods of Sequence Analysis:** Identification of Genes in a Genomic DNA Sequence, Principles of Sequence , Similarity Searches , Algorithms for Sequence Alignment and Similarity Search

4. **Practical Issues:** Getting the Most Out of BLAST, Protein Annotation in the Absence of Detectable Homology

5. **Genome Annotation and Analysis**: Methods, Approaches and Results in Genome Annotation, Genome Context Analysis and Functional Prediction.

6. **Comparative Genomics and New Evolutionary Biology:** Three Domains of Life, Prevalence of Lineage-specific Gene Loss and Horizontal Gene Transfer in Evolution, Tree of Life: Before and After the Genomes, Major Transitions in Evolution- A Comparative-Genomic Perspective

7. **Genomes and the Protein Universe:** Protein Universe , Highly Structured and Few Common Folds, Structural Genomics- Counting the Beans.

8. Distributions of Protein Folds and Super families in Genomes, Some Models of Genome Evolution, Evolutionary Dynamics of Multi-domain Proteins and Domain Accretion

Text Books:

1. Sequence - Evolution – Function- Computational Approaches in Comparative Genomics, Eugene V Koonin and Michael Y Galperin, Kluwer Academic-Boston, ; 2003, ISBN-10: 1-40207-274-0

Reference Books:

2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Baxevanis, A.D. and Francis Ouellette, B.F Second Edition, Wiley-2004
3. Proteome Research: New Frontiers in Functional Genomics, Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors), Springer Verlag Berlin Heidelberg- 1997
4. Fundamentals of Molecular Evolution, Graur, D. and Li, W-H, Sinauer Ass., USA.-2000
5. Mastering Perl for Bioinformatics, Tisdall, D., O'Reilly, 2003

MTCSTBI 2.6 Elective IV 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. **Introduction:** Introduction to Fuzzy sets and Fuzzy systems, Abstraction Pattern classification, Fuzzy Algorithm, Fuzzy Languages, Relation to Human and Machine Intelligence, Fuzzy Mapping Control, Limitations of Fuzzy Systems
2. **Classical Sets and Fuzzy Sets**: Operations on Classical Sets, Properties of Classical sets, Mapping of Classical sets to Functions, Definition of Fuzzy Sets, Operations on Fuzzy Sets, Properties of Fuzzy Sets, Alternative Fuzzy Set Operations

3. **Fuzzy Membership Functions:** Membership value Assignments , intuition, inferences, rank ordering, Neural networks, Genetic Algorithm, Inductive Reasoning

4. **Automated Methods For Fuzzy Systems:** Definitions, Batch Least Square Algorithm, Revised Least Square Algorithm, Gradient method, Clustering method, Learning from examples, modified learning from examples

5. **Fuzzy System Simulation:** Fuzzy relation equations ,non-leaner simulation using Fuzzy systems, Fuzzy associative memories[FAMS],

6. **Decision Making with fuzzy Information:** Fuzzy synthetic Evaluation, Fuzzy Ordering, Ranking, Performance and consciousness, Multi objective Decision Making, Fuzzy Bayesian decision Method, Fuzzy Decision Making under Fuzzy states and Fuzzy Actions

7. **Fuzzy Control Systems:** Control systems Design Problems, Assumptions in Fuzzy Control System Design, Simple Fuzzy Logic Controller, Example of Fuzzy Control System Design, Air Craft Landing Control problem, Fuzzy Engineering Process Co0ntrol, Fuzzy Statistical Process Control- Measurement Data-Traditional SPC, Attribute Data-Traditional SPC,

8. **Advanced Concepts:** Fuzzy Optimization, One-dimensional Optimization, Fuzzy Cognitive Mapping, Concept Variables and Casual relations, Agent Based Model,

Text Books:

1. Fuzzy Logic With Engineering Application , Timothy J.Ross, John Wiley & Sons Publishing Company

MTCSTBI 2.7 Computational Biology LAB

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

COMPUTATIONAL BIOLOGY LABORATORY

PURPOSE
Provides an opportunity to practically verify the theoretical concepts already studied. It also helps the student to be familiar with the various Bioinformatics tools

INSTRUCTONAL OBJECTIVES
The students should be able to
1. Know about the different databases available online.
2. Learn about sequence alignment and similarity

LIST OF EXPERIMENTS
1. Knowledge of different biological database
• Protein and gene sequence data bases
(NCBI, DDBJ, EMBL, SWISS PROT, PIR)
• Structure databases
(MMDB, PDB, FSSP, CATH, SCOP)
• Pathway Databases
(KEGG, BRENDA, METACYC, ECOCYC
• Bibliographic database
(PUBMED, MEDLINE)
2. Sequence retrieval from biological database
3. Gene prediction methods
4. Analysis of protein sequence using Expasy.
5. Sequence similarity searching of nucleotide sequences
6. Sequence similarity searching of protein sequences
7. Multiple sequence alignment
8. Dynamic programming method- local alignment
9. Dynamic programming method- global alignment

REFERENCE BOOK
1. Lab Manual

MTCSTBI 2.8 PERL PROGRAMMING LAB

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

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1. Program to perform control statements and until, for, for each, while operations.
    a. To find greatest of 3 numbers
    b. To check whether a number is prime or not
    c. Generating fibonacci series.
    d. Palindrome.
2. To perform matrix addition & multiplication.
3. Functions and subroutines (Recursion, GCD & LCD).
4. Regular expressions.
5. String Operations.
    a. Concatenation& String length.
    b. Pattern recognisation and searching
    c. Translate DNA to RNA.
    d. DNA to protein by using Perl module.
6. Program to perform file handling.
7. Program- shift, un-shift, splice & slice.
8. Program to perform gc count, chop, chomp, reverse compliment.
9. File handling using arrays and scoping of variables.

TEXT REFERENCE:

Text book of

1. Perl Black Book
2. Beginning Perl by Simon Cozens
3. Advance Perl Programming by Sriram Srinivasan.

Online Sources:

http://www.tizag.com/perlT/perlstrings.php.
http://www.cs.cf.ac.uk/Dave/PERL/node56.html

MTCSTBI 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 45minutes + 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.