MATHEMATICS DEPARTMENT

M.TECH. BIO-INFORMATICS

Course of Study & Scheme of Examination
2016-17

Maulana Azad National Institute of Technology,
Bhopal

M.TECH - BIOINFORMATICS
(FULL- TIME)

FIRST SEMESTER

Course No.	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
BI-501	Bioinformatics Computing	3	-	-	3
BI-502	Biological Databases and their Management	3	-	-	3
BI-503	Biomathematics	3	-	-	3
BI-511 BI-512	Elective-I	3	-	-	3
BI-513 BI-514	Elective-II	3	-	-	3
BI-515 BI-516	Open Elective-I	3	-	-	3
BI-504	Lab Practice-I	-	-	2	2
BI-505	Seminar-I	-	2	-	2
				Total Credits-22	

SECOND SEMESTER

Course No.	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
BI-551	Data Mining and Data Warehousing in Bioinformatics	3	-	-	3
BI-552	Bio Modeling and Simulation	3	-	-	3
BI-553	Optimization Technique & Graph Theory	3	-	-	3
BI-561 BI-562	Elective-III	3	-	-	3
BI-563 BI-564	Elective-IV	3	-	-	3
BI-565 BI-566	Open Elective-II	3	-	-	3
BI-554	Lab Practice-II	-	-	2	2
BI-555	Seminar-II	-	2	-	2
					Total Credits-22

THIRD SEMESTER								
BI-648	Major Project Dissertation Phase-I	-	-	-	-	-	23	23
	Total	-	-	-	-	-	23	23
FOURTH SEMESTER								
BI-698	Major Project Dissertation Phase-II	-	-	-	-	-	23	23
	Total	-	-	-	-	-	23	23

List of Electives Semester I

Elective -I

BI-511 Molecular Biology & Molecular Genetics
BI-512 Data Structure and Algorithms in C

Elective-II

BI-513 Genome Informatics & Proteome Informatics
BI-514 Metabonomics and Metabolomics

Open Electives-I

BI-515 Numerical Techniques, Statistical & Probabilistic Methods in Bioinformatics
BI-516 Medical Informatics

List of Electives Semester II

Elective-III

BI-561 Bio-Inspired Artificial Intelligence and Soft computing Techniques
BI-562 Languages, Algorithms & Tools in Bioinformatics

Elective-IV

BI-563 Data Analysis in Biology and Evolution
BI- 564Computational Neuroscience

Open Electives-II

BI-565 Chemoinformatics & Drug Design
BI-566 Machine Learning Techniques in Bioinformatics

SYLLABUS

BI-501 – BIOINFORMATICS COMPUTING

Lecture – 3 *Credits-3*

Introduction, chronological history of Bioinformatics, evolution of Bioinformatics, Objectives of Bioinformatics, Importance of bioinformatics, Bioinformatics in business, future scope of Bioinformatics.

Bioinformatician and bioinformaticist, role, need and importance of Biology, Computer Science, mathematics and information technology in bioinformatics, biological classification and nomenclature, life in space and time.

Introduction, information networks, protein and genome information resources, DNA sequence analysis, pairwise alignment techniques, multiple alignment techniques, secondary databases, analysis packages.

The dawn of sequencing, the biological sequence or structure deficit, human genome project and its status, homology and analogy, web browsers, European molecular biology network, national centre for biotechnological information, specialized genomic resources.

Building a sequence search protocol, practical approach for structural and functional interpretation, introduction to analysis package, commercial databases, softwares and comprehensive packages, internet packages specializing in DNA and protein analysis.

BOOKS:

1. Introduction to Bioinformatics – T.K. Attwood and Parry Smith
2. Introduction to Bioinformatics – Arthur M. Lesk
3. Fundamental Concepts in Bioinformatics – Krane and Raymer

BI-502 - BIOLOGICAL DATABASES AND THEIR MANAGEMENT

Lecture – 3 *Credits-3*

Introduction to database: Data Abstraction, Data `Models, Basic concepts of database: Data Independence DML, DCL, DDL and structure of Data Base Management System, Entity relationship diagram: Basic and Advance concepts Application of ER diagram in designing database system. Relational Algebra, Tuple Relational Calculus

Database design issues, Normalization 1NF, 2NF, 3NF, 4NF, BCNF and 5NF, database design problem. Security and Integrity: Use of SQL for specifying Security and integrity. Authorization, view, Encryption. Storage structure indexing and hashing. Different type of file organization.

Transaction & concurrency control, Schedules, testing, serializability, Lock based Protocol, Time stamp protocol, validation technique, Multiple granularity, Multi-version scheme Insert and delete operation, Crash recovery, Log based recovery, buffer management checkpoints, shadow paging. Object oriented databases.

Distributed database structure, Design transparency and Autonomy, Distributed Query processing Recovery, commit protocol Deadlock handling, Multidatabase system, Parallel database concept and related issues, Web interface to database, Database System Architecture

Introduction to biological databases, Nucleic acid sequence data banks: Genbank, EMBL, DDBJ, TrEMBL, GenPept, nucleotide sequence databank, cDNA databanks, AIDS Virus sequence data bank, rRNA data bank, Protein sequence data banks: NBRF-PIR, SWISSPROT, Signal peptide data bank etc.

REFERENCE BOOKS:

(i) Database System Concept By C.J. Date.

(ii) Database System By Aho. Ullman.

(iii) Database Systems By Rob, Coronel.

BI-503 - BIOMATHEMATICS

Lecture – 3 *Credits-3*

Growth and Decay Models in Biological; Population in Natural and Laboratory Environments. Intoxicants and Nutrients. Stability Analysis Interacting Population with Predation; Basic Models and Their solutions.

Epidemic Models; Deterministic models with and without Removal, General Deterministic Models with removal and Immigration. Control of an Epidemic, Stochastic Epidemic Model without removal.

Models in Genetics; Basic models for Inheritance, Further Discussion of Basic Model for Inheritance of Genetic Characteristics, Models for Genetic Improvement: Selection and Mutation, Models for Genetic Inbreeding

Pharmaco-Kinetics, Compartmental Models in terms of System of Differential Equations. Bio-diffusion. Diffusion of Drugs. Trans-Capillary Exchange. Oxygenation and Deoxygenating of Blood. Cardio Vascular Flow Patterns. Temperature regulation in Human Subjects.

Curve Fitting and Biological Modeling; Fitting curves to Data, The Method of Least Squares, Polynomial curve Fitting.

Text Books:

1. Mathematical Biology- J. D. Murray
2. Mathematical Models in Biology and Medicine. By J. N. Kapur
3. Mathematical Models in Biology; An Introduction. By Elizabeth S. Allman and John A. Rhodes
4. Linear Models in Biology (Pharmacy): By Cullen
5. Bio-Fluid Mechanics: By F. C. Fung
6. Introduction to Mathematical Biology: By Rubinov.

ELECTIVE-I

BI-511 - MOLECULAR BIOLOGY & MOLECULAR GENETICS

Lecture – 3 *Credits-3*

Introduction to Molecular biology, central dogma of Molecular biology, kind of data used in Bioinformatics, information molecules, basic structures of nucleotides. DNA, RNA, amino acids, and Proteins, genetic code, introns, exons, open reading frames, functions of various information molecules, different tools and techniques in molecular biology.

DNA as a genetic material, DNA replication, Biochemical structure, Recombination, Polymerase Chain reaction (PCR), DNA fingerprinting. Trancription, synthesis of RNA from template DNA strand, types of RNA, structure and functions of mRNA, tRNA, and rRNA, splicing of RNA transcript, translation, biochemical aspects of protein biosynthesis, post translational targeting and modifications.

Science of genetics – objectives, terminologies, methods, Mendelian principles of inheritance, sex linked inheritance, Concept of linkage, linkage maps and recombination, manipulation of genetic material vectors, detecting target DNA, techniques involved in gene manipulation.

Mutations – gene mutations, chromosomal aberrations, polyploidy, molecular gene/point and chromosomal mutation, Phenotype and genotype relationships, from gene to phenotype, gene interactions, Study of quantitative traits, gene transfer, applications of genetic engineering.

Regulation of gene expression, role of gene expression during cell differentiation, Genetics of populations, genetics and evolution, role of environment, Genetics and diseases, Cancer, HIV-AIDS etc.

BOOKS:

1. Basics Of Molecular Biology - Dr. R . N. Singh
2. Cell and molecular biology, Rastogi et al.
3. Molecular evolution:Computer analysis of protein and nucleic acid sequences – Doolittle, Russel, Academic Press.
4. Principles of population genetics – Hartl and Clark.

BI-512 - DATA STRUCTURE & ALGORITHM IN 'C'

Lecture – 3 *Credits-3*

Introduction to data structure, Primitive data structure, Static and Dynamic storage, Sub-algorithm function, procedure, parameters, parameter passing call by value, call by ref. Introduction to Algorithm analysis for time and space requirement, Rate of growth and Order of notation Basic time and space analysis of an algorithm, String Manipulation and Pattern matching Markov Algorithm Primitive and composite function, string manipulation Application - Text handling only, Abstract Data Types.

Non-linear data structures - Concept and Technology of Storage structure of arrays row major column major Stacks Definition, concepts, operation and application of Stacks, Recursion and Polish notations. Queue, Priority Queue definition concepts operation and application of Queue, Dqueue.

Linear data structures - Pointers and linked allocation concepts and operations on singly linked list, circular linked list, doubly linked lists Associative list Application of linked linear list, Polynomial Manipulation, Multiple precision arithmetic.

Trees - Definition and concepts storage representation and Manipulation of Binary tree conversion of general tree to Binary trees, Threaded Binary tree, Multi-linked structure, sparse matrices, Height balance tree, Multi weight tree, B tree, B+ tree, graph and their representation Matrix representation of graph Breadth first and depth first search, shortest path algorithm.

Internal Sorting External sorting - Selection sort, Bubble sort Merge sort quick sort, radix sort, Tape sorting; Shell sort, Poly phase and Oscillating sorting, (taking best case/worst case examples) sorting on Disk, Searching-Sequential search, Binary search, Search trees, Hash table methods.

BOOKS :

1. Data Structure - Tremble & Sorenson
2. Data Structure in `C' Language : by Tanenbaum
3. Data Structure by Bhagat Singh
4. Data Structure by Horowitz & Sohani

ELECTIVE-II

BI-513 – GENOME INFORMATICS & PROTEOME INFORMATICS

Lecture – 3 *Credits-3*

Genome Informatics: Gene Recognition, DNA Sequence Analysis. Accessing Sequence Data. Genome Databases. Mapping Sequence, Gene prediction. Gene Structure Prediction. Gene Expression Database. Gene Regulation and Expression. Probabilistic models of genome sequences. Statistical sequence analysis. Sequence alignment. Data Mining in Genome. Neural Network in Genome Informatics. Introduction to Human Genome Computing. Software for Human Genome Sequencing. Human EST Sequences. Genome Analysis: bacteria, viruses. Functional genomics, Comparative genomics.

Genome Informatics Application: Design Issue Feature Presentation, Data Encoding Neural Network.

Nucleic Acid Sequence Analysis.

Proteome Informatics: The promises of Proteomics: Biology, Application and Challenges. Accessing Sequence Data, Protein Structure, Protein Structure Prediction. Proteomics technologies and Bioinformatics. Public Protein Databases and Interafaces. Proteomic Knowlwdge Database. Proteome Knowledge Bases in the context of Cancer. Data standards in Proteomics. Data Standardization and Integration in Collaborative Proteomics. Informatics Tools for Functional Pathway Analysis Using Genomics and Proteomics. Data Mining in Proteomics, Protein Expression Analysis. Protein Identification by Searching Collections of Sequences with Mass Spectrometric Data. Statistical Design and Analytical strategies for Discovery of Disease-Specific Protein Patterns. Application of Proteomics: Biomedical, Pharmaceutical.

BOOKS:

1. Bioinformatics – A practical guide to the analysis of Genes and Proteins – Baxevanis and Fancis Ouellette, Wiley Interscience, New York.
2. Computational Molecular Biology – An algorithmic approach – Pavel A. Pevzner
3. Modern Genetic Analysis: Integrating Genes and Genomes - AnthonyJ.F. Griffiths, William M. Gelbart, Jeffery H. Miller.
4. Proteome Research: Concepts, Technology and Application (Principles and Practice) by M.R. Wilkins, R.D. Appel, K.L. Williams and D.F. Hochstrasse
5. Informatics In Proteomics by Sudhir Srivastava
6. Principles of Proteomics (Advanced Texts) by Richard M. Twyman
7. Computational Biology and Genome Informatics by Cathy H. Wu, Paul P. Wang and Jason T. L. Wang
8. Neural Networks and Genome Informatics, Volume 1 (Methods in Computational Biology and Biochemistry) by C.H. Wu and J.W. McLarty (Oct 5, 2000)
9. Modern Genome Annotation: The Biosapiens Network by D. Frishman and Alfonso Valencia
10. Introduction to Computational genomics by Nello Cristianini, Matthew W. Hahn

BI-514 METABONOMICS & METABOLOMICS

Lecture – 3 *Credits-3*

Introduction to Metabonomics and Metabolomics, their role and application. Analytical methods for metabolome science. Mass spectrometry for Metabolite Identification. Metabolomics: Data Integration and Data Mining. Integrating Profiling of Metabolites and proteins. Integrating profiling data using linear correlation to reveal co regulation of transcript and metabolites. Visualization and analysis of molecular data. Analysis to metabolomic data. Application of Metabolome Analysis to Biosciences, Lipidomics. Metabolome Informatics: Introduction to ARM Database, Genome based E-Cell Modeling. Metabolic Network. Metabolomics and Medical Science. Databases and Standardisation of reporting methods for metabolite studies. Metabonomics and Global Systems Biology: Example of use of metabonomics in normal and disease models, the Microbiome an integral part of global systems, Pharmaco-metabonomics, combining Omics.

BOOKS

1. The Handbook of Metabonomics and Metabolomics by John C. Lindon, Jeremy K. Nicholson and Elaine Holmes .
2. Metabolomics: A Powerful Tool in Systems Biology (Topics in Current Genetics) by Jens Nielsen and Michael C. Jewett.
3. Metabolomics, Metabonomics and Metabolite Profiling (RSC Biomolecular Sciences) by Royal Society of Chemistry, William J Griffiths, Stephen Neidle and David M J Lilley.
4. Metabolomics: Methods and Protocols by Wolfram Weckwerth.
5. Metabolomics: The Frontier of Systems Biology by M.Tomita, T.Nishioka.
6. Metabolomics, Metabonomics and Metabolite Profiling by Wiliam J Griffiths, Royal Society of Chemistry

OPEN ELECTIVE-I

BI-515- NUMERICAL TECHNIQUES, STATISTICAL & PROBABILISTIC METHODS IN BIOINFORMATICS

Lecture – 3 *Credits3*

Numerical Techniques:
Numerical Analysis: Difference operators, errors and approximations, Interpolation, Numerical Differentiation, Numerical Integration by using Trapezoidal, Simpson's 1/3 and 3/8 rule, Weddle, Gauss-Legendre, Monte Carlo methods of integration.
Solution of Algebraic and Transcendal Equation: Newton-Raphsan method,Newton's method for multiple roots, Lin-Barstow's and Graeffe's method for complex roots, Solution of Non-linear equations.

Statistical Methods:
Introduction to Statistical Methods. Estimation and Inference. Sampling distributions of estimators. Non parametric methods, categorical data. Introduction to Experimental Design. Introduction to Statistical Inference. Linear Statistical Model. Principal Component Analysis and Applications in Bioinformatics. Cluster Analysis and Applications in Bioinformatics. Algorithm Design. Supervised and Unsupervised Learning. HMM. Expectation Maximization. R for Statistical Modeling.

Discriminant Analysis and Applications in Bioinformatics. Stochastic Processes - Poisson Process and Markov Chains. Classical Estimation Theory. Classical Hypothesis Testing Theory.

Probabilistic Methods:

Introduction to Probability Theory. Random variables and their distribution. Discrete random variables. Continuous random variable. Markov Chain. Introduction to Learning Bayesian Networks from Data. Probabilistic Modeling & Inference: Sequence Models, Hidden Markov Model. Probabilistic Graphical Models in Bioinformatics. A Casual View of Multi-Layer Perception as Probability Model. Introduction to Statistical Phylogenetics. Detecting Recombination in DNA Sequence Alignment. Inferring Genetic Regulatory Networks from Microarray experiments with Bayesian Networks. Probabilistic Models of Evolution.

BOOKS:

1. Statistical Methods in Bioinformatics, Warren Ewens, Gregory Grant, Springer
2. Probabilistic Modeling in Bioinformatics and Medical Informatics, Dirk Husmeier, Richard Dybowski, Stephen Roberts, Springer
3. B.S. Grewal : Numerical Methods, Khanna Publications.
4. B.S. Grewal : Numerical Algorithms, Khanna Publications.
5. Krishnamutrhy & Sen : Numerical Algorithms EWP.
6. M.K. Jain & Iyengar: Numerical Methods for Scientists & Engineers.
7. Biostatistics: a foundation for analysis in the health sciences - Wayne W. Daniel.
8. Numerical Methods for Scientists and Engineers by R. W. Hamming, McGraw Hill.

BI 516 - MEDICAL INFORMATICS

Lecture – 3 *Credits-3*

Introduction, history of medical informatics, prospects of medical informatics, hospital information and management system, computerized physician order entry, health and disaster management plan,

Medical expert systems, computer based patient records, polyclinic module, computer assisted medical and patient education, three dimensional imaging, virtual endoscopy

Three dimensional navigation systems, surgical simulations, volume image data file, computer assisted surgery (CAS), merits and demerits of CAS, virtual environment, materials and methods for virtual environment

Telecommunication based medical systems, telemedicime and tele surgery, internet and its relay chat, internet grateful med (IGM).

BOOK:

1. Medical Informatics – A primer By Mohan Bansal
2. Bioinformatics basics applications in biological science and medicine, Rashidi et al.
3. Biomedical Signal Analysis - Rangaraj M. Rangayyan.

SECOND SEMESTER

BI-551 - DATA MINING AND DATA WAREHOUSING IN BIOINFORMATICS

Lecture – 3 *Credits-3*

Need for data warehouse, definition, goals of data warehouse, Data Mart, Data warehouse architecture, extract and load process, clean and transform data, star, snowflake and galaxy schemas for multidimensional databases, fact and dimension data, Designing fact tables. partitioning, partitioning strategy – horizontal partitioning, vertical partitioning,

Data warehouse and OLAP technology, multidimensional data models and different OLAP operations, OLAP Server: ROLAP, MOLAP and HOLAP. Data warehouse implementation, efficient computation of data cubes, processing of OLAP queries, indexing OLAP data.

Data preprocessing, data integration and transformation, data reduction, Discretization and concept Hierarchy Generation, Data mining primitives, Types of Data Mining, Data Mining query language, Architectures of data mining. data generation & Summarization based characterization, Analytical characterization, Mining class comparisons, Mining descriptive statistical measures in large data bases.

Mining Association Rules in large databases: Association rule mining, single dimensional Bookan association rules from Transactional DBS, Multi level association rules from transaction DBS, multidimensional association rules from relational DBS and DWS, Correlation analysis, Constraint based association mining.

Classification and Prediction : Classification by decision tree induction, Back propagation, Bayesian classification, classification based in association rules, Prediction, classifier accuracy, Cluster analysis, partitioning and hierarchical methods, Denrity based methods Grid based methods, web mining, Temporal and spatial data mining.

Text Books:

1. Building Data Ware House by W.H.Inmon, John Wiley & Sons
2. Data warehousing by S . Anahory and D.Murray, Pearson Education, ASIA
3. Data Mining Concepts & Techniques by Jiawei Han & Micheline Kamber; Harcourt India PVT Ltd.
4. TMH Oracle 8i Building Data Ware Housing by Michall Corey, M.Abbey, I Azramson & Ben Taub.
5. Data Mining, Practical Machine Cearing tools & techniques with Java by I.H. Whiffen (Morgan Kanffmen)
6. Data Ware Housing with oracle by Sima Yazdanri & Shirky S. Wong
7. Data Mining Techniques by A.K. Pujari , University Press.

BI-552 - BIOMODELLING AND SIMULATION

Lecture – 3 *Credits-3*

System Models : Concept, environment, stochastic activities, continuous and discrete simulation, Model Type- static, dynamic and probabilistic models. Growth and Decay model examples. Principles of Mathematical modeling, static physical model, system modelling.

Continuous systems models, differential equations, analog computers, analog methods, hybrid computer, analog simulations, continuous system simulation, languases, CSMP III hybrid simulation, feedback system, simulation of an interactive system, real time simulation.

Discrete system simulation, probability concepts in simulation, random number generations and their testing, stochastic variable generation, fixed time stop versus event to event model.

Simulation of queuing systems, arrival pattern, Poisson arrival pattern, exponential distributions, hyper-exponential distribution, service times, simulation of a single-server queue, normal distribution, measures of queues.

Simulation languages, continuous and discrete simulation languages, block-structured continuous simulation languages, GPSS, SIMSCRIPT, SIMULA, factor in selection of a discrete simulation language.

BOOKS:

1. Gordan – Simulation and Modeling - PHI.

2. System simulation and modelling - Narsingh Dev - PHI

BI-553 - OPTIMIZATION TECHNIQUES AND GRAPH THEORY

Lecture – 3 *Credits3*

Linear Programming, Mathematical Model, Assumptions of Linear Programming, simplex Method, Degeneracy, Applications, Duality, Dual Simplex Method, & Algorithm Assignment Problem. Hungarian Method & its Algorithm.

Transportation Problem, Integer Programming: - Gomorra's method, Branch and Bound techniques. Integer Programming Algorithm, Dynamic Programming:- Bellman's Principle of optimality, Dynamic Programming Approach, optimal subdivision problem, Decomposition, Applications in linear programming.DPP Algorithms.

Queuing Theory : Queuing problem and system, Transient and steady state distributions in queuing system, Poisson process, Exponential process, classification of queuing models, Model I (M/M/1) : (∞/FCFS), Model -II General Erlang Queuing model, Model - III (M/M/1) : (N/FCFS), Model - IV (M/M/S) : (∞/FCFS), Algorithms.

Inventory Theory :- Basic concepts, classification of Inventory systems & models, Economic order quantity, Deterministic Inventory models :- EoQ Models without shortages, EoQ Models with shortages, Probabilistic Inventory Models with instantaneous demand, no set up cost model, Discrete and continuous cases.

Games Theory : solution of games with saddle points, Minimax-Maxmin principle for Mixed strategy games, Dominance, to reduce size of game, Graphical method, solution of (mxn) game by simplex method & Algorithms, Job sequencing : Processing n jobs through 2 machines, Processing n jobs through 3 machines & Algorithms, PERT – CPM: introduction, applications, network diagram representation, Determination of the critical path, updating.

Graph Theory: Introduction, Digraphs, Paths and Subgraphs, Bipartite Graphs. Planar Graphs. Euler's Formula. Platonic Graphs. Coloring. Connectivity of graphs, Tours and Matchings, graphs on surfaces, directed graphs and undirected graphs, Flows, Random Graphs.

TEXT BOOKS :

1. S.D. Sharma, Operations Research, Kedarnath Ramnath & Co. Meerut
2. P.K.Gupta & D.S.Hira Operations Research, S.Chand & Co.
3. Kantiswaroop Operations Research, S.Chand & Sons.
4. Gillet, B.E.Introduction to operations Research - A Computer Algorithm Approach, McGraw Hill.
5. Introduction to operations Research, 7/e by Hillier. TMH.
6. Introduction to Graph Theory by Richard Trudeau
7. Graph Theory (Graduate Text in Mathematics) by Reinhard Diestel, Springer.

ELECTIVE-III

BI-561 – BIO-INSPIRED ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING TECHNIQUES

Lecture – 3 *Credits-3*

Introduction to AI various types of production system. Analysis of problem for developing an AI system. Problem characteristics, Production system and its characteristics. BFS, DFS, and Different heuristic search techniques- Hill climbing, Ascent Hill climbing, Constraint satisfaction. A* algorithm AO* Algorithm,

Knowledge Representation: Representation and mappings, Approaches to knowledge representation, Issue in knowledge representation, Knowledge representation using predicate logic resolution, and unification algorithm. Knowledge representation using rules procedural versus declarative knowledge logic programming, Forward and back ward reasoning. Symbolic reasoning under uncertainty monotonic and non monotonic reasoning. Semantic nets, Frames Conceptual dependency.

Natural language processing and study of its different phases, Game planning Minimax Search procedure, Adding Alpha Beta cut-offs, Iterative deepening Planning components of planning system Goal stack planning Nonlinear and Hierarchical planning.

Statistical reasoning Probability and Bayes Theorem Certaininty factor and rule base system Bayesian Networks Dempster Shafer Theory Fuzzy Logic. Understanding Parallel and distributed AI Psychological Modeling, Parallelism in reasoning system.

Introduction to learning, various learning techniques Introduction to Expert System. Connectionist Model Hopfield networks learning in Neural Networks Application Common Sense Common Sense ontologies and Memory organizations.

TEXT BOOKS :

1. AI by Rich & Knight.
2. AI by Norwing.

BI-562 - LANGUAGES, ALGORITHMS & TOOLS IN BIOINFORMATICS

Lecture – 3 *Credits-3*

Sequence comparison, Sequence similarity search, computational models for sequence analysis, sequence alignment, longest common subsequence problem, alignment with gap penalties, space efficient sequence alignment, Scoring matrices for similarity search PAM, BLOSUM etc.

Comparing a sequence against a database, method of sequence database similarity search, BLAST, FASTA, and other methods for comparing databases of sequence and patterns- PSI-BLAST, PHI-BLAST & PROBE etc.

Methods of optimal alignment, distance and similarity, motifs & patterns, evolutionary basis for sequence alignment, Smith Waterman, Needleman and Wunsch dynamic programming algorithms, progressive alignment methods, alignments presentation methods, multiple sequence alignment (MSA), practical aspects of MSA, tools and applications of MSA.

Programming languages – Perl, Bioperl, Java, Biojava, HTML, BioXML etc.,

Bioinformatic Tools – Genscan, Rasmol, Cn3D, Phylip, Oligo, Clustal W, ALSCRIPT, MOLSCRIPT etc.

BOOKS:

1. Perl for Bioinformatics – Tisdall and James.
2. Introduction to Bioperl – Tata Mc Graw Hill.
3. The complete reference –Java2, Patrick Naughton et al.

ELECTIVE-IV

BI-563 – DATA ANALYSIS IN BIOLOGY & EVOLUTION

Lecture – 3 *Credits-3*

Introduction to Data Analysis. File Conversion. Processing Gene Bank Files. Pairwise and Multiple sequence alignment. Factors affecting nucleotide frequencies. Case study of arthropod phylogeny. Factors affecting codon frequencies. Transcription and codon usage bias. Translation and codon usage bias. Evolution of amino acid usage. Pattern of nucleotide substitutions. Preamble to pattern of codon substitution. Factors affecting codon substitution. Transition bias. Substitution pattern in amino acid sequences. Statistical digression. Theoretical background of genetic distances. Molecular phylogenetics. Testing the molecular clock hypothesis. Testing phylogenetic hypothesis. Fitting probability distributions.

Introduction to trees, concept of evolutionary trees, phylogenetic trees, relationship of Phylogenetic analysis to sequence alignment, genome complexity and Phylogenetic analysis, sequence alignment based on evolutionary model. Methods of phylogenetic analysis like distance matrix, Fitch and Margoliash method, maximum parsimony method, maximum likely hood method, unweighted pair group method with arithmetic mean (UPGMA), neighbour-joining method and character based methods, evaluation of phylogenetic methods. Converting sequence similarity to distance scores, choosing an outgroup, correcting of distances between nucleic acid sequences for multiple changes and reversions, comparison of protein sequences and protein encoding genes, comparison of open reading frames by distance methods. Reliability of Phylogenetic predictions, problems and complications from Phylogenetic analysis, automated tools for Phylogenetic analysis, bootstrapping and jack knife replicates, jumbling sequences.

Books:

1. Bioinformatics – Sequence and Genome analysis By David W. Mount
2. Molecular Evolution and Phylogenetics – Nei and Kumar.
3. Data Analysis in Molecular Biology and Evolution by Xuhua Xia, Springer

BI-564 - COMPUTATIONAL NEUROSCIENCE

Lecture – 3 *Tutorial – 1* *Credits3*

Introduction: Structure and functions of Neurons, passive electrical properties of neurons, signal spread, principles of electrical circuits, the cable equation, electrical models of real neurons, ion permeability and membrane potential at equilibrium: the Nernest equation, the Nernest plank equation.

Ion pumps and homeostasis: sodium and potassium, the sodium pumps, the potassium pumps, calcium, anions, the regulation of pH, action potential, Hadgkin Huxley experiments, Hadgkin Huxley model, the mechanism of action potential.

The structure and function of voltage gated channels: structure of sodium and potassium channels, the channel pore, mechanism of activation and inactivation, the diversity of voltage gated channels: sodium channel, potassium channel, calcium channel.

Pre Synaptic mechanism of synaptic transmission, gap junctions, electrical synapses, modulation of electrical synapses, chemical synapses and the calcium hypothesis.

Excitatory transmission, Acetyl choline and cholinergic transmission, glutamate and glutametergic transmission, inhibitory transmissions, structure of GABA receptor and Glycine receptor.

Books references:

1. Molecular and cellular physiology of neurons by Gordon L. Fain.
2. Brain facts by Candle.

OPEN ELECTIVE-II

BI-565 - CHEMOINFORMATICS & DRUG DESIGN

Lecture – 3 *Credits-3*

Introduction & Scope of Cheminformatics, history of cheminformatics, use of cheminformatics, evolution of cheminformatics, future scope of cheminformatics. Representation of chemical compounds, chemical reactions, various types of line notations. Chemical Information Resources, Chemical Structure Database.

Searching chemical compounds, calculation of Physical and chemical data, calculation of structure descriptor. Introduction to QSAR, QSPR.

Introduction to drug discovery, areas influencing drug discovery, important parameters in drug discovery, technologies and strategies in drug discovery, cell cycle – key to drug discovery, introduction to pharmacogenetics and pharmacogenomics, applications of pharmacogenetics and pharmacogenomics. Drug life cycle, drug development time lines, definition of drug discovery, stages of drug discovery, strategic issues in drug discovery, emerging approaches to drug design and discovery, strategy to identify possible drug target molecules.

Computer aided drug design, methods of computer aided drug design, ligand design methods, docking algorithms and programs, drug design approaches, absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design.

BOOK:

1. Introduction to Chemoinformatics by Andrew R. Leach, Valerie J. Gillet
2. Introduction to Computational Chemistry by Frank Jensen
3. Targeted and Controlled Drug Discovery - S.P.VYAS and R.K.Khar
4. Bioinformatics – Genomics, Proteomics, and Drug Discovery, Rastogi et al.

BI-566 - MACHINE LEARNING TECHNIQUES IN BIOINFORMATICS

Lecture – 3 *Credits-3*

Introduction to Machine Learning (ML). ML Foundation: the probabilistic framework. Probabilistic Modeling and Inference. ML Algorithms: Dynamic Programming, Gradient Descent, EM. Neural Network theory and application. Hidden Markov Model theory and application.

Probabilistic graphical models in bioinformatics. Probabilistic models of evolution. Stochastic grammars and linguistics. Microarray and gene expression. Feature selection for proteomic and genomic data mining.

BOOKS:

1. Bioinformatics – Machine learning approach by Baldi & Brunak
2. Statistical methods in Bioinformatics: an introduction – Ewens and Grant.