

# Syllabus for B.Tech. in Bioinformatics

## Semester-I

### **BINF111 : Applied Mathematics**

#### **Algebra of matrices:**

Elementary transformation, inverse by row transformation, canonical reduction, rank, solution of simultaneous equations, characteristic equation, eigen values – & eigen vectors. Caley-Hamilton theorem, similarity transformation, reduction to diagonal matrices.

#### **Differential Calculus:**

Higher order derivatives (successive differentiation) and Leibnitz theorem, indeterminate form, tangent and normal, review of maxima and minima, concavity and convexity of a curve, point of inflexion, curvature and radius of curvature, pedal equation, asymptotes (for Cartesian curve only), Taylor's and Maclaurin's series, partial derivatives, Euler's theorem on homogeneous functions, harmonic function, Taylor's expansion of several variables, maxima & minima of several variables- Lagrange's method for undetermined multipliers.

#### **Differential equation:**

First order equation, separable, homogeneous, exact, linear and Bernoulli's form, Second and Higher order equation with constant coefficients, Euler's equation: Methods of their solution, dependent and independent of solution- Wronskian's system of first order equation.

#### **Integral calculus:**

Definite integrals, Beta & Gamma functions (definition & related problems), error function, differentiation under integral sign- Leibnitz rule.

#### **Text Books:**

1. Advance Engineering Mathematics- R. K. Jain & S. R. K. Iyenger, Narosa Publishing House.
2. Higher Engineering Mathematics – B. S. Grewal, Dhanna Publishers.
3. Differential calculus – Das & Mukherjee – U. N. Dhar & Sons.
4. Integral calculus – Das & Mukherjee – U.N. Dhar & Sons.

#### **Reference Books:**

1. Advance Engineering Mathematics- E. Kreyszig, 8<sup>th</sup> Edition John Wiley & Sons. New York.
2. Advance Engineering Mathematics- Wylie & Barrett- Tata McCraw Hill.
3. Linear Algebra – K. Hoffmann and R. Kunze – Prentice Hall.
4. Differential calculus – Laljee Prasad.
5. Integral calculus – S.N. Thakur and S.B. Prasad
6. Differential Equations - Laljee Prasad

### **BINF112 : Applied Physics**

**Electrostatics and Electromagnetic theory:** The three electric vectors, to show that normal component of D and tangential component of E are continuous across the boundary between two dielectrics, Continuity equation for charge, displacement current, Maxwell's Equation in free space, speed of plane electromagnetic waves traveling in vacuum, pointing vector, electromagnetic waves propagation in dielectrics in dielectrics and conductors.

**Optics and Lasers:** Temporal coherence, Michelson's interferometer for measurement of coherence length of a source, line width spatial coherence, measurement of spatial coherence using Young's interferometer, Fraunhofer diffraction by single slit, double slit and grating. Lasers and Laser Lights, Einstein's A and B coefficients and laser, population-inversion. Light amplification, optical resonators, resonators, Characteristics of lasers, Ruby Laser, How He-Ne laser works.

**Polarization:** Unpolarized light, production of plane polarized light by Polaroid technique (principle of action to be emphasized) Brewster's law, Malus law. Double refraction, production of circular and elliptical lights, analysis of unpolarized and polarized lights, Magneto-optics effect, photo-elastic effect, electro-optic effect.

**Special theory of Relativity:** Michelson – Morleys Expt., Postulates of special theory of relativity, consequences of special theory of relativity, Galilean transformation, Lorenz transformation.

**Quantum Physics:** Planck's theory of black body radiation Compton effect wave particle duality, deBroglie waves, deBroglie wave velocity, wave and group velocity, Davission and German experiment Heisenberg uncertainty principle, application of the uncertainty principle, wave functions and wave equations, Physical interpretation of wave function and their normalization, Expectation values, Schrödinger's equation time dependent form and steady state form in one dimension (Quantum mechanical operators) particle in a box, potential barrier and tunneling.

#### **Text Books:**

1. Concept of Modern physics; by Arthur Beiser; Publication: TMH
2. Elements of Electromagnetic; by Mathew N. O. Sadiku Pub: Oxford University Press
3. Introduction to Electrodynamics; by David J Griffiths; Pub: Pearson Education.
4. Optics; by Ajoy Ghatak; Pub: TMH
5. Fundamentals of Physics Extended Volume; by Resnick Halliday and Walker; Pub: John Wiley & Sons, Inc. Asian Edition.

#### **Reference Books:**

- 1 Modern Physics; by G. Aruldas & P Rajagopal; Pub: Prentice Hall of India.
- 2 Quantum Physics; by H. C. Verma Pub: Surya Publications
- 3 Lasers and Non-Linear Optics; by B. B. Laud; Pub. New Age International (P) Ltd.
- 4 Principle of Electricity; by Leigh Page and Norman IIsley Adams; Pub: Eurasia Publishing House, New Delhi.

## **BINF113 : Cell Biology**

Prokaryotic and eukaryotic cells, physical structure of model membranes in prokaryotes and eukaryotes, lipid bilayer, membrane proteins, Structural organization and functions of cell organelles: nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, lysosomes, Chloroplast, Structure of chromatin and chromosomes.

protein trafficking and sorting, Cell signaling, Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, modulation of G-proteins through small molecules, activators, and antagonism, signal transduction pathways, second messengers, and regulation of signaling pathways.

#### **Literature Recommended:**

1. Alberts Bruce, Johnson Alexander, Lewis Julian, Raff Martin, Keith Roberts, Walter Peter. Molecular Biology of the Cell. 5th edition. Publisher: Garland Science; 2008. ISBN: 9780815341062.
2. Watson James D., Baker Tania A., Bell Stephen P., Alexander Gann, Levine, Michael Losick Richard. Molecular Biology of the Gene 6th Edition. Publisher: New York, Cold Spring Harbor Laboratory Press. 2008. ISBN: 9780321507815
3. Brown, T.A. Genomes 2 Publisher: New York, BIOS Scientific Publishers Ltd. 2002, ISBN: 1859960294
4. Alberts Bruce, Bray Dennis, Hopkin Karen, Johnson Alexander D, Julian, Lewis Raff Martin, Keith Roberts, Walter Peter. Essential Cell Biology. 3rd Edition Garland Science, 2010. ISBN-10: 0815341296

## **BINF114 : Basic Electrical Engineering**

**Introduction:** Electrical Elements and their classification, KCL, KVL equation and node voltage method, D.C. circuits steady state analysis with independent and dependent sources, Series and parallel circuits, star delta conversion, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer Theorem.

**A. C. circuits:** Common signals and there waveform, RMS and Average value, form factor and peak factor of sinusoidal wave, impedance of series and parallel circuits, Phasor diagram, Power, Power factor, Power Triangle, coupled circuits, Resonance and Q-factor, Superposition, Thevenin's and Norton's Maximum Power transfer theorem for A.C. circuits.

**A. C. circuits:** 3- phase: Star delta, line and phase relation, Power relations, Analysis of balanced and unbalanced 3-phase circuits.

**Magnetic circuits:** Introduction, Series & Parallel magnetic circuits, Analysis of Linear and non-linear magnetic circuits, Energy storage, A. C. excitation, Eddy current and hysteresis losses.

**Basic indicating instruments for measurement:** Current voltage, Power, Energy Insulation resistance.

**Text Book:**

1. Basic Electrical Engineering by Fitzgerald, etal, Tata McGraw Hill

**Reference Books:**

1. Fundamentals of Electrical Engineering By Leonard S. Bobrow, Oxford.
2. Fundamentals of Electrical Engineering by R. Prasad, PHI Publication

## **BINF116 : Fundamental of Information Technology**

**Computer Basics:** Evolution of Computers, Generation and Classification of Computers, Application of Computers, and etc

**Computer Memory and Storage:** Memory Hierarchy, RAM, ROM, Types of Secondary Storage Devices, and etc.

**Information Technology Basics:** Information, Technology, Role of Information Technology, Information Technology and Internet. and etc.

**The Internet and its Tools:** Introduction, Evolution of Internet, Basic Internet Terms Getting Connected to Internet, Internet Applications, data over Internet, Web Browser Browsing Internet Using Internet Explorer, E-mail, Search Engines, Instant Messaging

**Emerging Trends in IT:** E-Commerce, Electronic Data Interchange, Smart Cards Mobile Communication, and etc.

**Computer Programming and Languages:** Algorithm, Flow Chart, Pseudo Code Program Control Structures, Programming Languages, Generation of Programming Languages, and et..

**C Language:** Basics, Constants, Variables and Data Types, Operators and expression Input & Output operations.

**Control Structures:** Decision Making & Branching, Decision Making & Looping.

**Arrays:** One & Two dimensional Array.

**Functions:** User defined functions, concept of recursion.

**Text Books:**

01. Introduction to Information Technology, by ITL Education Solution Ltd., Pearson Education
02. Programming in ANSI C by E Balagurusamy 4<sup>th</sup> Ed

**Reference Books**

01. Fundamental of Computer & IT By A. Jaiswal (Weily India)
02. Programming in ANSI C by Ashok N. Kamthane
03. The C programming Language, 2e, by Brian W. Kernighan & Dennis M. Ritchie PHI/Pearson Education
04. Programming with C by Gottfried. Tata McGraw Hill (Schaum's Series).
05. Mastering C by K. R. Venugopal, & S. R. Prasad, Tata McGraw Hill

## **BINF117 : FIT Lab**

1. Working in Windows environment, Internet, C
2. Programming based on above syllabus.

## **SEMESTER-II**

## **BINF121 : Biophysics**

Elementary Biophysics, DNA Biophysics, Protein Biophysics, Carbohydrate Biophysics, Techniques in Biophysics.

## **BINF122 : Environmental Science & Engineering**

Environmental Education and Ecosystems, Environmental Pollution, Waste Management, Biodiversity and its conservation, Environmental Protection. Water Supply and Sewage Disposal. Biosensor and Environmental Monitoring, Xenobiotics.

## **BINF123 : Biochemistry –I**

Structure, Function, Properties and Metabolism of Carbohydrates, Proteins, Lipids, Fatty acids, Amino acids, Metabolism of Nucleotides, Use of KEGG pathways database, Inborn errors in metabolism, Electron transport and Oxidative Phosphorylation. Classification, Nomenclature and Properties of Enzymes, Enzyme action and Regulation, Michaelis-Menten Equation.

## **BINF124 : Basic Electronics Engineering**

Passive Components & Signal sources.

**Semiconductor Diodes** – P-N Junction Diode, dc and incremental Parameters, DC Load- Line, Q point or DC Operating Point, Temperature Effect, Ideal Diode, incremental resistance, Small Signal Equivalent Circuit, Junction Capacitance & Diffusion Capacitance, Avalanche & Zener Breakdowns

**Diode Applications** – Half-wave & Full-wave Rectification, Center Tap & Bridge Rectifier, Filters Zener Voltage Regulation, Percentage regulation, PIV, Ripple Factor, R-C, L-C &  $\pi$ -filters, Voltage Doublers, Clipping & Clamping Circuits.

Special Application Diodes: Photo-Diode, Light-Emitting-Diode (LED), Tunnel Diode, Varactor Diode, Schottky Diode

Bipolar Junction Transistor (CB & CE output and transfer characteristics, dc and incremental parameters) and its application-CE, CC, CB- DC Bias analysis and Incremental Analysis using simple hybrid- $\pi$  model.

FET & MOSFET – Transfer and Output Characteristics of JFET, enhancement- MOSFET, depletion- MOSFET & Amplification Action in Common Source FET Amplifier; Amplifiers – Multistage Amplifiers, Feed – Back Amplifier, its four topologies and its advantages; Integrated Circuits-Ideal Operational Amplifier (Op-Amp), Applications as Inverting Amplifier, Non-Inverting Amplifier, Summer, Difference, Integrator and Differentiator and nonlinear, application as precision rectifiers, logarithmic amplifiers and multi-vibrator. Introduction to – Wien Bridge, RC –phase shift, Hartley and Colpitts Oscillators

### **Text Book**

1. Electronic Devices & Circuit Theory by Boylestad and Nashelsky, Pearson;
2. Electronic Principles, Albert Malvino & Davis J. Bates, 7<sup>th</sup> Ed. TMH.
3. Art of Electronics by Paul H. Horowitz, Oxford;

### **References**

1. Introduction to Electronic Circuit Design by Spencer, Pearson;
2. Device Electronics for Integrated Circuits by Muller & Kamins with Mansun Chan Wiley Student Edition
3. Principles of Electronics by V.K. Mehta, S.Chand
4. Electronic Circuit & System by R.J.Smith Wiley;

## **BINF128 : Basic Electronics Engineering Lab**

1. Introduction to DMM (Digital Multimeter):
2. Introduction to passive components (Resistance, capacitance and inductors)-specification and measurements of the actual values by DMM;
3. Introduction to Cathode Ray Oscilloscope (CRO)- Time period measurement, study of different Waveforms, measurement of frequencies of Sinusoidal wave forms by Lissajou's Figure;
4. Introduction of connectors-multi-strand wires (connecting wires) & single strand wires (hook up wires) and bread boards;
5. Study of Output characteristics of Diode, BJT, FET, UJT & SCR;

6. Application of Diode, BJT, FET, UJT & SCR- Clipping & Clamping, Rectification, Rectification, RC coupled CE and CS FET Amplifiers, Relaxation Oscillator;
7. Application of UA 741-Inverting Amplifiers, Non-inverting Amplifiers Summer Amplifiers. Difference amplifiers, Integrator and Differentiators.

## BINF125 : Molecular Biology

Nucleic acid structure and their types, DNA Replication, Transcription, Translation, Central Dogma of Molecular Biology, Gene and Genome Structure and Organization in Prokaryotes and Eukaryotes, Gene regulation, Operon theory, Molecular Mechanisms of Recombination in Bacteria, DNA Damage and Repair, Host Controlled Restriction and Modification, RFLP, Gene Expression, DNA Sequencing,

## BINF126 : Applied Chemistry

**Water Treatment:** Introduction, Characteristics imparted by impurities in water. Hardness of water. Unit of hardness. Estimation of hardness of water. Disadvantage of hard water. Scale and Sludge formation in boilers, Caustic embitterment, Boiler corrosion, Priming and Foaming. Softening methods. Desalination of Brackish water.

**Electrochemistry & Corrosion of metals and its prevention:** Galvanic cell, Electrode Potential, Nernst equation, Galvanic Series, law of dry Corrosion (Parabolic, Linear, and Logarithmic law). Wet Corrosion, Type of Corrosion (Pitting, Intergranular, Crevice Corrosion, Waterline Corrosion, Stress Corrosion). Protective measures against corrosion by (i) modification of environment, (ii) modification of metals (iii) Use of protective Coatings (vi) Cathodic protection.

**Chemical Thermodynamics: First Law :** Statement, work done in isothermal, adiabatic conditions, work and heat path dependent function, heat changes, isochoric and isobaric conditions, heat capacity, Cp & Cv relations, Kirchoff's relation.

**Second Law:** Need of 2<sup>nd</sup> law, Spontaneous process, Reversible process, carnot cycle, concept of entropy, Entropy changes as function of temperature, entropy change during the phase transformation, Gibb's free energy, Free energy change under various conditions. Free energy changes as criteria of reversible and irreversible process. Gibb's helmohltz's equation.

**Organic reaction mechanism:-** Inductive effect, hyperconjugation and Resonance Their importance in Organic Chemistry. A brief discussion of reactive intermediates – Carbonium ion, Carbanion, Carbene & free radical. Types of organic reaction: Substitution, addition and elimination reactions, Mechanism of polymerization. Thermosetting & Thermoplastic resins, Engineering use of Polymeric materials. Organic insulation and dielectric materials biopolymers.

**Fuels:-** Classification of fuels, primary and secondary fuels, Calorific value of fuels, Proximate and Ultimate analysis of coal. Significance of the constituents. Determination of Calorific value by bomb calorimeter, Petroleum refining. Knocking and its prevention. Analysis of flue gas by orsat's apparatus, combustion calculation, Nuclear fuel, solar power, rocket fuel and hydrogen as alternative fuel.

**Fundamentals of Microwave:** - IR and UV-VISIBLE Spectroscopy. Basic concepts of spectroscopy. Selection rule. Determination of molecular structure.

### Text Book:

1. Chemistry in engineering & Technology; Vol.-I and II, by J.C.Kuriacose & J.Rajraman Pub:TMH
2. Engineering Chemistry by Jain & Jain; Pub: Dhanpat Rai Publication
3. Engineering Chemistry by B.K.Sharma; Pub: Kirshna Prakashan Media pvt. Ltd.
4. Essential of Experimental Engineering Chemistry by Shashi Chawla; pub: Dhanpat Rai Publication

# **BINF127 : Communication Skill**

Basic Grammar : Structural pattern; single word substitution; Editing .  
Common errors, Comparison  
Antonyms; Homonyms; Sentence building (Vocabulary) Reading and writing (Comprehension)  
Precis, Essay & Paragraph writing.  
Expansion (word & phrase)  
Official Correspondence, Memorandum; Circular letter  
Applying for a job ; Resume  
Business Correspondence; Report writing.  
Phonetics(Symbol and Transcription); pronunciation, Reading-developing reading skill.

## **Text book:**

1. English Grammar- Wren & martin
2. English Grammar- Dr. D.Thakur
3. English Grammar- J. Nesfield
4. Technical English - Sharon j Gerson and Steven M Gerson
5. Business Communication – P.D. Chaturvedi & M. Chaturvedi- Pearson Pub.

## **Reference books:**

1. Communication in English for Technical Student-Orient Longman
2. Business Correspondence & Report writing –R. C. Sharma & Krishna Mohan – Tata Magraw Hill:

## **Semester-III**

### **BINF211 : Biostatistics**

Introduction, Probability and Theoretical Distributions: (Binomial, Poisson and Normal), Testing of Hypothesis, Analysis of Variance, Standard deviation and Variance, Test of Significance, Chi Square test of independence and Homogeneity, Test based on z and t-distribution, Statistical Quality Control, Random models

### **BINF 212 : Biochemistry II**

**Complex Carbohydrates Oligosaccharides:**Glycosidic bonds;Classification: glycoproteins (O-linked and N-linked) glycolipids; Nature of carbohydrate moiety attached; Functions; as cell recognition factors, in intracellular targeting; Purification and Characterization of oligosaccharides from cell membranes

**Polysaccharides:**Classification:Homopolysaccharides(Cellulose,Starch, Chitin, and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin); Structural characteristics and functions of above mentioned polysaccharides; Exopolysaccharides from bacterial systems and their uses; Purification and Characterization of Polysaccharides from biological systems.

#### **Complex Lipids**

**Glycerophospholipids:** Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl

Glycerol, Phosphatidylcholine, Phosphatidyl inositol, plasmalogens) CDP-diacylglycerol, Lung surfactants.

**Glycosphingolipids:** Structure and function of (Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides)

**Eicosanoids:** Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function.

**Steroids:** Steroids in animal system: Glucocorticoids, mineralocorticoids and Sex hormones (Site of biosynthesis and functions). Sterols in Plant system: Phytohormones: Brassinosteroids (function); Sterols in microbial system.

**Protein structure and function:** Primary, Secondary, Tertiary and Quaternary structure of Proteins w.r.t: Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein (Collagen), Membrane Protein (ATP synthetase); Structural implication of the peptide bond-rigid planar peptide unit-cis and trans configuration-conformations of a pair of linked peptide units- torsion angles: phi and psi- steric hindrance- allowed and disallowed conformation – Ramachandran diagram – conformational maps of glycine and other natural amino acids. Protein structure and molecular approach to medicine: introduction Sickle cell anemia, p53 and its role in Cancer.

**Nucleic acid structure and function:** Types of DNA-A, B and Z. Supercoiling of the DNA molecule; topoisomers and superhelixes; Higher orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes; Conformation of Chromatin fibers; Organization of the DNA Sequence: Genes, pseudogenes, extragenic regions (beta globin gene and gene family) duplicated genes; Reassociation kinetics, Repetitive DNA sequences: Tandem repeats (Satellites, minisatellites, and microsatellites), Interspersed repeats (LINE, SINEs) Single copy genes; RNA Structure: Types of RNA; structure of mRNA, tRNA, siRNA, micro RNA with emphasis on importance of structure to its function.

## **BINF213 : Molecular Genetics**

Mendelian Genetics, Linkage Mapping, Cell Division, Sex Determination, Mutation and their role in Evolution, P Genetic Disorders, Genetic code, Gene Expression and Regulation, Crossing over and Linkage, allele, QTL, RAPD, AFLP Marker Structural Changes in the Chromosome. Polyploidy, Aneuploidy. Pedigree analysis, Introns, Exons, Junk DNA and Capping, Cot-Curve and C-value Paradox, Law of DNA Constancy, Repetitive DNA, hn RNA, Holliday model,

## **BINF216 : Introduction to Bioinformatics**

General Introduction and history of bioinformatics, advanced internet search, overview of bio-informatic resources on the web NCBI / EXPASY, DNA and protein sequence database: GenBank, Searching GenBank through Entrez search engine, SwissProt, sequence submission, various file formats in bioinformatics, bibliographic resource and literature database.

PDB, SCOP, small molecule database: ZINC, Natural product database, Biochemical pathway database: KEGG, Gene expression and genome databases, Interaction databases, Gene ontology: ontology structure, ontology relations, cellular component, molecular function and biological process ontology, Patenting and IPR issues in bioinformatics.

### **Literature Recommended:**

1. Attwood T, Parry-Smith DJ (2001) Introduction to Bioinformatics. Pearson Education
2. Claverie JM, Notredame C (2003) Bioinformatics for Dummies. John Wiley & Sons
3. Mount DW (2001) Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press
4. Singh HB (2016) Intellectual Property Issues In Biotechnology. CABI

## **BINF215 : Computer Architecture**

**Introduction:** Computer Arithmetic, Instruction sets, Introduction to computer organization, CPU Design.

**Micro programmed Control:** Control Memory, Address sequencing, Micro program example.

**Memory and Input-Output Subsystems:** Hierarchical memory structure, Cache memories, Set Associative memory, Virtual Memory, Paging, Segmentation, Input-Output Interface, Asynchronous Data Transfer, Programmed I/O, Interrupts, Direct Memory access.

**Introduction to Parallel Processing:** Evolution of computer systems (RISC vs. CISC), Parallelism in uniprocessor systems, Architectural classification schemes.

**Principles of Pipelining and Vector processing:** Pipelining, Overlapped Parallelism, Principles of designing Pipelined processors,

Vector Processing Requirements.

**Structures & Algorithms for Array Processors:** SIMD Array processors, SIMD Interconnection networks

**Text Books:**

1. Computer System Architecture. 3e by M. Morris Mano, Pearson Education.
  2. Computer Architecture and parallel processing by Kai Hwang, Briggs, McGraw Hill
  3. Computer Architecture by Carter, Tata McGraw Hill.
- Computer System Organization & Architecture by John D. Carpinelli, Pearson Education

## **BINF214 : Object Oriented Programming using c++**

**Introduction to C++:** Object Oriented Technology, Advantages of OOP, Input-output in C++, Tokens, Keywords, Identifiers, Data Types C++, Derives data types, The void data types, Types Modifiers, Typecasting, Constant, Operator, Precedence of Operators, Strings.

**Control Structures:** Decision making statement like if-else, Nested if-else, go to, break continue, switch case, Loop statement like for loop, nested for loop, do-while loop,

**Function:** Parts of Function, User-defined Functions, Value-Returning Function, Void Functions, Value Parameters, Function overloading,

**Classes and Data Abstraction:** Structure in C++, Class, Built-in Operations on Classes, Objects (Variables), Member functions, Accessor and Mutator Functions, Constructors, default Constructor, Destructors,

**Overloading & Templates:** Operator Overloading, Function Overloading, Function Templates, Class Templates

**Inheritance:** Single & Multiple Inheritance, Virtual Base class, Abstract Class, Pointer and Inheritance, Overloading Member Function. Virtual function .

**Pointers and Arrays:** Void Pointers, Pointer to Class , Pointer to Object, The this pointer, Void Pointer, Arrays.

**Exception Handling:** The keywords try, throw and catch. Creating own Exception Classes, Exception Handling Techniques (Terminate the Program, Fix the Error and Continue, Log the Error and Continue). Stack Unwinding.

**Text Books:**

1. Thinking in C++, Volume 1 & 2 by Bruce Eckel, Chuck Allison, Pearson Education,
2. Mastering C++, 1/e by Venu gopal, Tata McGraw Hill
3. Object Oriented Programming with C++, 3/e by E. Balagurusamy, Tata McGraw Hill
4. Starting Out with Object Oriented Programming in C++, by Tony Gaddis, Wiley India

**Reference Book:**

1. The C++ Programming language 3/e by Bjarne Stroustrup, Pearson Education
2. C++ How to Program, 4e, by Deitel, Pearson Education
3. Big C++ by Cay Horstmann, Wiley India.
4. C++ Primer, 3e by Stanley B. Lippman, Josee Lajoie, Pearson Education.
5. C++ and Object Oriented Programming Paradigm, 2e by Debasish Jana. PHI
6. Programming with C++ 2/e by Ravichandran, Tata McGraw Hill
7. C++ Programming Black Book by Steven Holzner, Dreamtech Press



## **BINF217 : OOP Lab**

Writing programs using classes and objects, constructors and destructors, Inheritance properties, Overloading operators, Use of pointers list representation. Programs and virtual functions, file handling, I/O manipulator using C++

## **BINF218 : Bioinformatics Lab**

- Searching biological databases, NCBI, EMBL, Swiss-prot and PDB
- Finding similar sequences (DNA/proteins) in databases: use of different version of BLAST and interpretation of BLAST results.
- Multiple sequence alignments using web-based and stand-alone version of CLUSTAL. Interpretation of results to identify conserved and variable regions and correlate them with physico-chemical & structural properties.
- Prediction of ORFs. Gene Prediction in prokaryotes and eukaryotes.

## **SEMESTER IV**

## **BINF220 : Fundamentals of Microbial Biotechnology**

History and Introduction to Microbiology, Morphology, Classification and Multiplication of Virus, Bacteria, Yeast, Cyanobacteria and Protozoa, Growth Kinetics, Microbial Nutrition, Isolation and Cultivation of Bacteria, CFU, MPN, Microbial Photosynthesis, Fermentation, Anaerobic Respiration, H.I.V. Host pathogen interaction, Extremophiles, Microbial Infections. Kinds of Plasmid. Bacteriophage, Vaccines.

## **BINF221 : Bioinformatics Algorithm**

Homologous, orthologous, paralogous and xenologous sequences, Alignment of pair of sequences, scoring matrices (PAM and BLOSUM) and gap penalties, dot plot method, dynamic programming algorithm as applicable to global (Needleman-Wunsch) and local (Smith - Waterman) sequence alignment. Database searching for similar sequences: Heuristic algorithm FASTA, BLAST and their types. Multiple sequence alignment (MSA), dynamic programming for MSA, heuristic approach to MSA, progressive sequence alignments method, Clustal W/X, Branch and bound and other methods for MSA, Whole genome alignments: concepts and applications, Cluster of Orthologous Groups. Promoter prediction in prokaryote and eukaryotes, Prediction of genes and gene structure for prokaryotic and eukaryotic organisms, RNA structure prediction algorithms, Prediction of splice sites. Application of machine learning Techniques (Genetic algorithms, Markov chain and Hidden markov models, Neural networks, Graph matching algorithms, Support vector machine, Nearest-neighbour methods (clustering).

### **Literature Recommended:**

1. Cormen TH, Leiserson CE, Rivest RL, Stein C (2009) Introduction to Algorithms. The MIT Press
2. Dey DK, Ghosh S, Mallick BK (2010) Bayesian Modelling in Bioinformatics. Chapman and Hall
3. Gusfield D (1997) Algorithms on Strings, Trees, and Sequences. Cambridge University Press
4. Jones NC, Pevzner PA (2004) An Introduction to Bioinformatics Algorithms. The MIT Press
5. Klir GJ, Yuan B (1995) Fuzzy Sets and Fuzzy Logic: Theory and Applications. Prentice Hall
6. Mitchell T (1997) Machine Learning. The McGraw-Hill Company
7. Mitra S, Dutta S, Perkins T, Michailidis G (2008) Introduction to Machine learning and Bioinformatics. Chapman and Hall
8. Mount DW (2001) Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press

9. Rao SS (1991) Optimization: Theory and applications. Wiley Eastern Ltd
10. Sharma V, Munjal A, Shanker A (2016) A Text Book of Bioinformatics. Rastogi Publications
11. Waterman M (1995) Introduction to Computational Biology: Maps, sequences and genomes. Chapman & Hall
12. Witten IH, Frank E, Hall MA, Pal CJ (2011) Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann

## **BINF222 : Recombinant DNA Technology**

Vectors and Insert, DNA Ligase, Linker, Adapter, Homopolymer Tailing, Construction of Gene Libraries, Expression of Recombinant DNA in E. Coli., Application of Recombinant DNA Technology.

## **BINF226: Bioinformatics Algorithm Lab**

- Finding similar sequences (DNA/proteins) in databases: use of different version of BLAST and interpretation of BLAST results.
- Multiple sequence alignments using web-based and stand-alone version of CLUSTAL. Interpretation of results to identify conserved and variable regions and correlate them with physico-chemical & structural properties.
- Gene Prediction in prokaryotes and eukaryotes.
- Primer designing.
- Prediction of promoters using Neural Network Promoter Prediction (NNPP).
- Prediction of alternate splice sites using methods such as Splice Site Prediction by Neural Network.
- Using sequence-based and structure-based Function Annotation Servers such: ProKnow (<http://www.doc-BIS.ucla.edu/Services/ProKnow/>), Joined Assembly of Function Annotations (JAFA) at <http://jafa.burnham.org/learnMore.html>.
- Predicting protein function from 3D structure using ProFunc.

## **BINF225 : Numerical Methods & Computational Techniques**

**Introduction to computer language :** Machine language, assembly language, higher level language, compilers, problem solving using computer algorithm, flow chart, examples.

**C/C++ Programming :** Constant & variables, arithmetic expression, I/O statement, specification statement, control statements, subscripted variables, logical expression, function and subroutines, examples of programming should include numerical as well as non numeric applications, matrix operations, searching , sorting etc.

**Iterative Techniques for solution of equations :**

**i. Solution of non linear equation** - Simple iteration scheme, Bisection method, Regula-falsi method, Newton - Raphson method, Secant method, their rates of convergence, order of errors etc.

**ii. Solution of linear equation** – Gaussian elimination, matrix inversion by Gaussian method, computation of determinants, Jacobi and Gauss Seidel iteration method.

**Polynomial approximation :** Interpolation, several form of interpolating polynomials like Lagrangian interpolation of polynomial and Newtons forward and backward difference formula, curve fitting(least square) .

**Numerical integration :** Trapezoidal method, Simpson's rule, order of errors in integration.

**Solution of initial value problem :** Euler's method, Runge-Kutta second order and fourth order methods, solution of boundary value problem - Finite difference method.

**Text Books:**

1. Numerical methods for scientific and engineering computations  
by M.K. Jain, S.R.K. Iyengar, and

R.K.Jain, New Age International Publishers, New Delhi.

2. Introductory Method of Numerical Analysis by S.S. Sastry, Prentice Hall of India Pvt. Ltd.

#### **Reference Books**

1. Numerical Analysis in Engineering by Rama B. Bhat, S. Chakravarty, Narosa Publishing House.

2. Advanced Engineering Mathematics by E.Kreyszig, 8th edition by John Wiley & Sons, New York.

## **BINF224 : Web Technology**

**Web Introduction:** Domain name, IP Address concepts, World Wide Web

**HTML & CSS:** Introduction to HTML, Tags, Commands, Formatting web page, Font Tag, Links and Listings, Images and its Mapping Tables, Frameset Definition, Forms, Cascading Style sheet (CSS).

**JavaScript :** Introduction, data types, variables, operators, Array Objects, Date Objects, String Objects, Document Object Model, Image Object, Event Handling, Browser Object, Window Object, Location Object, History Object, Submit event and data validation.

**Dynamic Hypertext markup language (DHTML):** Introduction to DHTML, Dragging and Dropping data, working layers.

**Java Fundamental:** Introduction to Java, Java and the Internet, Data type, Variables, Operators, Strings, Input and Output, Control Flow, Arrays., Object and classes, members of classes, Inheritance, Interfaces.

**Graphics and Applet Programming in Java:** Introduction to Abstract Window Toolkit (AWT) and Swing, Event Handling, Working with Text input, Choice Components, Menus Dialog Boxes. Applets and deploying Applets with HTML, Jar Files, Exception Handling, Introduction to Multi- Threading in Java.

**Database Programming:** JDBC API.

#### **Text Books:**

1. HTML Black Book By Steven Holzner(Wiley India)
2. JAVA – How To Programm, by Deitel & Deitel, (Pearson)

#### **Reference Books:**

1. HTML, CSS, Java Script, Perl, Python & PHP ( Web Standard Programming Reference) BY ( Wiley India)
2. JAVA: The Complete Reference, J2SE, 5/e, by Schildt (TMH)
3. Web Programming by Bates, Wiley
4. Core Java TM Volume I & II by Cay S. Horstmann & Gary Cornell (Pearson)
5. Internet & WWW How to Program by by Deitel & Deitel, (Pearson)
6. HTML & XHTML: The Complete Reference byPowell, (TMH)

## **BINF228 : Web Technology Lab**

Programming based on above syllabus

## **BINF223 : Database Management Systems**

**Introduction:** Purpose of database systems, View of data, data models, & interface, Database language, transaction management, storage management, database administrator, database users, overall system structure, Classification of Database Management System, Three- Schema Architecture.

**Data Modeling:** Entity- Relationship Model, Basic concepts, design issues, mapping constraints, keys, E-R diagram, weak entity sets,

extended E-R features, design of an E-R database schema, reduction of an E-R schema to tables.

**Relational Model:** Structure of relational databases, relational algebra, tuple relational calculus, domain relational calculus, extended relational-algebra operations, modification of the database and view, SQL and Other.

**Relational Languages:** Background, basic structure, set operations aggregate functions, null values, nested sub-queries, derived database, joined relations DOL embedded SQL and other SL features, query-by-example.

**Integrity Constraints:** Domain constraints, referential integrity, assertions triggers and functional dependencies.

**Relational Database Design:** Pitfalls in relational database design, decomposition, normalization using functional, multi-valued and join dependencies, domain key normal form and alternative approaches to database design.

**Query Processing:** Overview, catalog information for cost estimation, measures of query cost, selection operation, sorting, join operation, other operations, evaluation of expressions, Translating SQL query into Relational Algebra, transformation of relational expressions, Query Optimization.

**Transactions:** Transaction concept, transaction state, system log, Commit point, Desirable Properties of a Transaction, concurrent executions, serializability, recoverability, implementation of isolation transaction definition in SQL, Testing for serializability

#### **Text Books:**

1. Database System Concepts 3<sup>rd</sup> edition, by A.Silberschatz H. F. Korth, & S. Sudhatshan, McGraw Hill,
2. Fundamental of Database Systems, by Elmasri, Navathe, Somayajulu, and Gupta, Pearson Education.
3. An Introduction to database system by C. J. Date, A. Kanana, S. Swamynathan, Pearson Education

#### **Reference Books:**

1. Database management System, by Rajesh Narang. PHI
2. Database Systems by Rob, COronel, Galgotia Publication.

## **SEMESTER-V**

### **BINF311: Genomics and proteomics**

Genomic diversity in microbes, plants and animals. GENE prediction Genome Alignments: BLAST2, MUMmer, Pip Maker, VISTA, Comparison of Gene Order Comparative Genomics Databases: COG, VirGen, CORG, HOBACGEN, Homophila, XREFdb, Gramene, Ensembl Single Nucleotide Polymorphism, dbSNP and other SNP-related databases High throughput data & its analysis: Gene Expression Analysis, Structural Genomics, Functional Genomics, Microarray Technology, Microarray data analysis, Real Time PCR

### **BINF312: Transcription and interaction Proteomics**

Goals of transcriptomics experiment, Understanding Microarray and Next generation sequencing data. Types of microarrays. Experimental design for comparing transcriptome, statistical power and number of replicates. Reproducibility of transcriptomic experiments. Data normalization methods, Filtering of non-informative probes. Supervised and unsupervised clustering. Cluster validation. Generating Heatmaps. Finding genes differentially expressed between two conditions. Making sense of list of differentially expressed genes, Gene regulatory networks. Cell mapping proteomics: finding protein protein interactions, Yeast two hybrid system. Phage display, Protein interaction maps, Protein networks. Protein microarrays, Protein-protein interactions: databases such as STRINGS, DIP, PPI server and tools for analysis of protein-protein interactions. Proteome analysis: Proteomics in relation to transcriptomics and Systems Biology.

### **BINF313: Structural Bioinformatics**

Nomenclature & terms used in molecular modelling, Computer representation & visualization of molecules, Internal coordinates, Steric criteria, Hard and soft spheres model, Atomic, ionic, covalent and van der Waal radii, Calculation of molecular geometry – bond length,

angle and torsion angles, Calculation of molecular volumes & surfaces - van der Waals, Connolly and solvent accessible surfaces, Ramachandran Map, Overview of experimental techniques to study macromolecular structures: X-ray crystallography, NMR & Cryo-electron microscopy, Structure consistency and validation tools: Procheck, WhatIF, & MolProbity. Principles of protein folding, Anfinsen paradigm, Levinthal paradox and Folding Funnel, Structural Classes, Motifs, Folds and Domain, Protein Secondary Structure Prediction Methods: Chou and Fasman, GOR, Neural Network & nearest neighbour methods, Tertiary structure prediction: homology modelling, fold recognition (threading) and ab initio methods, Structural comparison & alignment methods, VAST & DALI, Macromolecular interactions & Protein-Protein docking.

#### **Literature Recommended:**

1. Bourne PE, Weissig H (2003) Structural Bioinformatics (Methods of Biochemical Analysis, V. 44). Wiley-Liss Publisher
2. Branden CI, Tooze J (1999) Introduction to Protein Structure. Garland Publishing Inc, New York
3. Dieter HH, Wolfgang S, Didier R, Gerd F (2003) Molecular Modelling: Basic Principles and Applications. Wiley-VCH
4. Glusker JP, Trueblood KN (1994) Crystal Structure Analysis: A Primer. Oxford University Press
5. Jensen F (2017) Introduction to Computational Chemistry. John Wiley & Sons
6. Leach A (2001) Molecular Modelling: Principles and Applications. Prentice-Hall
7. Lewars EG (2003) Computational Chemistry. Kluwer Academic Publishers
8. Ramakrishnan C (2001) Ramachandran and his Map. Resonance – J Sci Edu 6:48-56.
9. Rappé AK, Casewit CJ (1997) Molecular Mechanics across Chemistry. University Science Book
10. Richard FA (2002) Computational Methods for Protein Folding: Advances in Chemical Physics. John Wiley & Sons
11. Schleyer PvR (1998) Encyclopaedia of Computational Chemistry. John Wiley & Sons
12. Sternberg MJE (1997) Protein Structure Prediction: A Practical Approach. Oxford University Press
13. Young DC (2001) Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems. John Wiley & Sons

## **BINF314 : Biological Sequence Analysis**

Introduction to primary sequence database, derived database: origin of Secondary and tertiary database regular expression, Prosite, Profile, Print, Pfam, e-motif, fingerprints. Database search, sequence similarity search methods, FASTA, BLAST, PSI BLAST, PAM and BLOSUM Matrices; Multiple sequence alignment and family relationship, protein families and pattern database, protein domain families.

#### **Literature Recommended:**

1. Bernhard OP (2007) Systems Biology: Properties of Reconstructed Networks. Cambridge University Press
2. Brown SM (2013) Next-generation DNA sequencing Informatics. Cold Spring Harbor Laboratory Press
3. Gentleman R (2005) Bioinformatics and Computational Biology Solutions Using R and Bioconductor. Springer
4. Julio CV, Ralf H (2002) Gene Regulation and Metabolism: Post- Genomic Computational Approaches. The MIT Press

## **BINF315 : Proteomics Technology & Applications**

Protein Targeting, Proteomes and Sub-proteomes, Expression and Analytical Proteome Analysis, Proteome Quantification, Gel Based Proteome Investigations (1D, 2D, GE, IEF, DIGE); Sequence Based Proteomic Analysis- MS, ESI, MALDI-TOF, HYBRID; LC/MS-MS, Protein Sequence Determination-Edman versus Peptide Sequencing and Mass Fingerprinting, Expression Proteome Analysis (Isotope Labeling and Label Free Approaches), Proteomic Identification of Post Translational Modification, DEEP SEQ MS, Shotgun Proteomics, Protein de novo Sequencing and Top Down Proteomics,

## **BINF316 : Structural Bioinformatics Lab**

- Exploring the Database & searches on PDB and CSD, WHATIF, ExPasy.
- Methods for prediction of secondary structure of proteins: Prediction of secondary structures of proteins using at least 5 different methods with analysis and interpretation of the results. Comparison of the performance of the different methods for various

classes of proteins.

- Methods for prediction tertiary structure of proteins along with analysis and interpretation of results: Homology modelling: Modeller, SWISS MODEL, SWISS PDBViewer; Fold recognition methods: PHYRE, TOPITS, GenThreader, I-TASSER, Verify 3D.
- Use of Steepest Decent and Conjugate Gradient for energy minimization of biomolecule.
- Oligopeptide/Oligonucleotide model building (PYMOL / DS tools / SwissPDBViewer).

## **BINF317 Sequence analysis lab**

- Sequence similarity searches, BLAST family of programs.
- Local and global alignment method
- Multiple sequence alignment; motif identification and regular expression.
- Multiple sequence alignment domain diagnosis family and superfamily identification

# **SEMESTER-VI**

## **BINF321: Molecular Phylogeny and Evolution**

Foundations in Molecular Evolution: Evolution, natural selection, phylogeny, convergent evolution, co-evolution. Evolution of genes in populations. Hardy-Weinberg equilibrium. Mutation; Migration; Selection; Genetic drift; measures of genetic diversity. The neutral and nearly-neutral theories of molecular evolution. Sequence Analysis, natural selection and clocks: Calculating evolutionary distances among sequences; correlation and models. Molecular clocks. Molecular phylogenetics: Concepts: Kinds of trees, rooting, clades, reconstructing character evolution, consensus trees. Parsimony and distance based phylogenetic methods. Maximum likelihood phylogenetics. Bayesian phylogenetics. Evolution of genome and gene families: Lateral gene transfer and transposition. Chromosomal evolution: Genome duplications. Orthology and paralogy. Gene duplication and divergence. Domain shuffling, concerted evolution and molecular drive. Phylogenetic analysis algorithms: Distance-based: UPGMA, Neighbor-Joining, Maximum Parsimony, Reliability of trees: Bootstrap, Jackknife, randomization tests.

### **Literature Recommended:**

1. Dan Graur and Wen-Hsiung Li. Fundamentals of Molecular Evolution.
2. Bernardi Giorgio. Structural and Evolutionary Genomics, Volume 37: Natural Selection in Genome Evolution (New Comprehensive Biochemistry). Publisher: Netherlands, Elsevier Science.2005. ISBN: 9780444521361.
3. Takahata Naoyuki, Clark Andrew G.(Editor). Mechanisms of Molecular Evolution: Introduction to Molecular Paleopopulation Biology. Publisher: Japan, Japan Scientific Societies Press and Sinauer Associates, Inc. 1993. ISBN: 476226718X.
4. Marco Salemi, Anne-Mieke Vandamme. The phylogenetic handbook: a practical approach to DNA and protein phylogeny. Publisher: Cambridge University Press, 2003. ISBN: 052180390X.

## **BINF 322 : Target Based Drug Designing**

Structure-Based Drug Design: Molecular Targets, GPCRs. Enzyme kinetics and interaction of enzymes with inhibitors, agonists and antagonist Lead identification & optimization, Active site analysis, Molecular Docking, Protein & Ligand preparation and conformational analysis, Rigid and flexible (induced-fit) & quantum polarized docking, Virtual screening and analysis of results, Compound Library ZINC, Maybridge etc., Library generation (focused & diverse). Combinatorial & Fragment libraries: Molecular Scaffolds, Reagents-based combinatorial library generation. Scaffold hopping, Fragment-based, de novo design. Multidrug Resistance

(MDR), pharmacokinetics: introduction to drug absorption, disposition, metabolism, elimination, toxicity (ADMET), ADMET and molecular properties prediction, prediction of site of metabolism (SOM), concept of prodrug & soft drug. Pharmacodynamics: mechanism of drug action, dose-response relationship, drug potency and efficacy, Pharmacogenetics: the genetics of drug metabolism, Introduction to biologics, Residue scanning, antibody design and modelling

#### **Literature Recommended:**

1. Barry AB, Brian S, Guillermo M, Jürgen B (2006) Chemoinformatics: Theory, practice, & products. Springer
2. Holtje HD, Sippl D, Rognan, Folkers G (2008) Molecular modelling basic Principles and applications (3rd Edition). Wiley-VCH
3. Johann G, Engel TE (2003) Chemoinformatics: A Textbook. Wiley-VCH
4. Johann G, Thomas E (2004) Chemoinformatics: A textbook.: Willey-VCH
5. Leach AR, Gillet VJ (2003) An introduction to chemoinformatics. Kluwer Academic.
6. Osman F Güner (2000) Pharmacophore Perception, Development, and Use in Drug Design. International University Line
7. Thomas L, Raimund M, Hugo K, Hendrik T (2002) Bioinformatics: From genomes to drugs Volume 1: Basic technologies. Wiley-VCH
8. Thomas L, Raimund M, Hugo K, Hendrik T (Series Editor) (2002) Bioinformatics: From genomes to drugs volume II: Applications. Wiley-VCH
9. Young DC (2009) Computational drug design: a guide for computational and medicinal chemists: John Wiley & Sons

## **BINF324 : Data Structures**

**Introduction to algorithm:** Analysis for time and space requirements.

**Linear Data Structures and Their Sequential Representation:** Array, Stack, queue, circular queue and their operation's and applications

**Linear Data Structures and Their Linked Representation:** Linked linear list, circularly linked linear list, Doubly linked list, linked stack, linked queue and their operations and applications

**Nonlinear Data Structures:** Binary trees, binary search trees, representations, operations, thread representations, sequential representation, traversals, applications, B-tree, Operation on B-tree, AVL Search tree and operations, Huffman Algorithm, Height Balanced Tree

**Sorting and Searching:** Bubble Sort, Insertion Sort, Selection Sort, Heap Sort, Quick Sort, Radix Sort, Linear and Binary search, Union-Find, Hashing methods, etc.

#### **Text Books:**

- Data Structure Using C by ISRD Group, Tata McGraw Hill
- Data Structures by Lipschutz & Pai, Tata McGraw Hill.
- Data Structure using C and C++ by Langsam, Pearson Education
- Data Structures by E. Horowitz and S. Sahni
- Data Management & File Structures, 2e, by Mary E.S. Loomis, PHI.
- Data Structures & Algorithm Analysis in C++, 2e, by Mark Allen Weiss, Pearson Education.
- An Introduction to Data Structures with application, Second Edition, by J. P. Tremblay and P.G. Sorenson, Tata McGraw Hill.

#### **Reference Books:**

- Data Structures using Java by Langsam, Moshe Augenstein, and Aaron M. Tenenbaum.
- C and Data Structures by P.S. Despande. Wiley India

## **BINF 323 Molecular Dynamics**

Overview of molecular modeling, Molecular modelling methods: Semi-empirical methods, Empirical methods. Introduction to

Molecular Mechanics: Newtonian Mechanics, Harmonic Oscillator, Force Fields and Types: Bonded Interactions (Bond length, angle, dihedral, improper torsion) and Non Bonded Interactions (Lennard-Jones Potential, Hydrogen bonding etc.). Molecular Mechanics: Conformational energy, Potential Energy surface and its characterization (Local, Global Transitions), Optimization Techniques: First order and second order optimization methods. Molecular Dynamics: Integrators, Solvation models, Molecular Dynamics in Explicit and Implicit Solvation, MD in constant Temperature and pressure. Conformations: global vs. local, Force fields: expressions for stretch, bond, torsion, etc., Description of various force fields: MM3, Dreiding, AMBER, CHARMM, Mechanics of Bio-macromolecules. Newton's equations for many particles, Verlet and related algorithms, Types of dynamics simulations: adiabatic, constant T, simulated annealing, etc., Conformational searching using MD and other methods, Free energy calculations, Dynamics of Bio-macromolecules, Electrostatics of biomolecules Energy Minimization: Golden section, derivative based method (SD, CG, Newton-Raphson)

## **BINF 327 Molecular Phylogeny and Evolution lab**

- Phylogenies: Neighbor joining, parsimony, maximum likelihood and Bayesian.
- Comparative genomics
- Evolutionary study of Protein sequences
- Compilation & curation of dataset, format conversion.
- Survey of software programs available for phylogenetic analysis: Installation of at least 2 public domain packages for both Windows & Unix environment: Phylip, PAUP, MEGA
- MSA using ClustalW: writing files for phylogenetic analysis : Informative and variable sites; Singleton sites etc., Difference between dendrogram & phylogenetic tree, Converting sequence data into distance data,
- Reconstruction of phylogenetic trees using molecular data: Distance-based methods: UPGMA, Neighbor-joining, Neighbor-relations & Transformed distance, Maximum Parsimony, Maximum likelihood Using bootstrapping tool to generate multiple datasets from the original input data & generation of consensus tree.
- Plotting, visualizing & printing phylogenetic trees: TreeView and other tools : Various rendering, Formatting & labeling, Interpretation of trees. Comparison of trees drawn using: RNA, Nucleotide & protein data, Gene trees & species tree. Unrooted & rooted tree, Rooting unrooted tree using an out group. Reconstruction of phylogenetic trees using whole genome data of viruses

## **BINF 328: Target based drug design lab**

- Importance of 3D structures and method of generation from 1D & 2D representations.
- Substructure/Exact/similar structure based searching.
- Property based search of molecular databases.
- Pharmacophore hypothesis and searching.
- Virtual screening and Docking studies (Rigid, Flexible & library based).
- Design and analysis of focused combinatorial and fragment library.
- De-novo drug designing.
- Drug target and Vaccine target identification.

## **Semester VII**

### **JAVA PROGRAMMING**

**Introduction to Java :** Feature to Java, Java Virtual Machine, Differences between C++ and Java, Part of Java, API Document, Starting



a Java Program. Important Classes, Formatting the Output

**Naming Conventions and Data Types :** Naming Conventions in Java. Data types in Java, Literals.

**Operators and Control Statements in Java :** Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Boolean Operators, Bitwise Operators, Ternary Operators, New Operator, Cast Operator, If else statement, Switch statement, Break statement, Continue statement, Return statement, do-while loop, while loop, for loop.

**Input and Output :** Accepting Input from the keyboard, reading input in Java, Util, Scanner class, displaying output with System.out. print (), Displaying formatted output with string, Format.

**Arrays and Strings :** Types of Arrays, Array name, Length, Command Line Arguments, Creating Strings, String Class Methods, String Comparison, Immutability of Strings, Creating String Buffer Objects, String Buffer Class Methods, String Builder Class, String Builder Class Methods.

**Introduction to OOPS :** Problems in procedure oriented approach, Features of Object Oriented Programming System, Object creation, Initializing the instance variable, Constructors.

**Methods of Java :** Method Prototype, Method Body, Understanding Methods, Static Methods, Static Block, The keyword 'this', Instance Methods, Passing Primitive Data Types to Methods, Passing Objects to Methods, Passing Arrays to Methods, Recursion, Factory Methods.

**Inheritance and Polymorphism :** Inheritance, The Keyword 'super', The Protected Specified, Types of Inheritance, Polymorphism with variables, Polymorphism using methods, Polymorphism with Static Methods, Polymorphism with Private Methods, Abstract Classes.

**Packages :** Package, Different types of Packages, Interface in a Package, Access Specifiers in Java.

**Exceptional handling :** Errors in Java Program, Exceptions throws and throw clause, Types of exceptions, Re- throwing an exception.

**Threads :** Single and Multitasking, Creating and terminating the thread, Single and Multi tasking using threads, Deadlock of threads, Thread communication.

**Introduction to AWT and Applets :** AWT components, Creating and closing the frame, Drawing in the frame, Displaying dots and text in the frame, Event Handling, Listeners and Listener methods, Creating and uses of Applets, An applet with swing components, Applet parameters.

**Introduction on Java database connectivity :** Database servers and clients, JDBC, Connecting to a Database, Stored Procedures and Callable Statement, Storing file and Image into database retrieving a file and images from database, Types of JDBC drivers.

#### **Text Books :**

1. Core Java by R Nageswara & Kogent Solution Inc, Dreamtech.
2. The Complete Reference Java Tata McGraw Hill.
3. Java 6 Programming Black Book, w/CD by Kogent Solutions Inc., Dreamtech .

#### **Reference Books:**

1. Professional Java, JDK 6 Ed. by Richardson AvondolioWrox.
2. Programming with Java by E Balagurusamy Tata McGrawHill.

## **BINF415 : Information Security**

**Information and Security Planning:** Introduction to Information Theory, Threat Agents and Risk Information and the Law, Information Security Planning Model

**Cryptographic Principles and Methods** Cryptographic Philosophy, Mathematical Principles of Cryptography, Symmetrical Key Cryptography, Public Key Infrastructure

**Information System Security** Securing the Information System Viruses, Worms, and c Malicious Software

#### **Text Books:**

01. Information Security Intelligence: Cryptographic Principles & Applications by Calabrese, Thomson

#### **Reference Books:**

01. Information Security Principles & Practice by Mark Stamp, Wiley
02. Introduction to computer Security by Bishop and Venkatramanaya, Pearson Education
03. Cryptography and Network Security: principles and Practice by Stallings, PHI

## **BINF414 : Data Mining**

**Fundamentals:** Three concept view, Supervised learning, Unsupervised clustering, Data Mining or Data Query, Expert System or Data Mining?, A simple data Mining Process Model, Data Mining Strategies, Supervised Data Mining techniques, Association Rules, Clustered Techniques, Evaluating Performance

**Basic Data Mining Technique:** Decision Trees, Generating Association Rules, K-Mear Algorithm, Genetic learning, Choosing Technique,

**An Excel-based Data Mining Tool: iData Analyzer.**

**Knowledge Discovery in Databases:** KDD Process model, Noisy data, Missing data, Data Transformation, CRISP-DM process Model.

**Data Warehousing:** Operational Database, Data warehouse design, OLAP, Excel Pivot Table for data analysis.

**Formal Evaluation Techniques:** Evaluation criteria, Tools, Computing Test Set Confidence Intervals, Comparing Supervised Learner Models, Attribute Evaluation, Unsupervised Evaluation Techniques

**Neural Networks:** Feed – Forward Neural Networks, NN Training, Building Neural Network with iDA

**Statistical Techniques:** Linear Regression Analysis, Logistic Regression, Bayes Classified Clustering Algorithm, Query and Visualization Techniques, Machine Learning and Statistical Techniques

**Specialized Techniques:** Time Series Analysis, Mining the Web Mining Textual Data Improving Performance

### **Text Books:**

01. Data Mining: A tutorial-based Primer, by Richard J. Roiger, Michael W. Geatz, Pearson Education
02. Data Mining Introductory & advanced topic, by Margaret H. Dunham, Pearson Education

### **Reference Books:**

01. Data Warehousing, Data Mining & OLAP by Berson/Smith, TMH
02. The Microsoft Data Warehouse Toolkit: With SQL server 2005 and the Microsoft business Intelligence toolset by Ralph Kimball, Wiley India
03. Building the Data warehousing by W. H. Inmon, Wiley India
04. Data Warehousing: Design, Development & best practices, by Soumendra Mohanty, McGraw Hill.

## **BINF411 : Biosafety, Bioethics, Intellectual Property Right and Patents**

Biosafety and GMOs in India, Regulatory Framework for GMOs, Bioethics, Research Methodology, Intellectual Property Rights, Copyright, Patent

## **BINF 413 : Ligand based drug design**

Chemoinformatics & chemical data formats: Introduction to Chemoinformatics: aims and scope. Role of Chemoinformatics in pharmaceutical/chemical research. Chemical Structure representation: 1D, 2D and 3D structures; Molecular file formats (SMILES, InChI, WLN, SDF, MOL), Molecular patterns- SMARTS, SMIRKS. Searching Chemical Databases. Chemical Structure based Search techniques: Exact, Substructure and similar structure searches. Molecular Descriptors (1D, 2D and 3D), Topological, electrotopological and shape indices. Compound classification and selection – cluster analysis, partitioning, chemical reaction database. Chemical Databases and Retrieval methods. Molecular Database Screening: (Lipinski Rule: Drug/Lead like molecules), Conformation generators History of SAR & QSAR, CoMFA and CoMISA, IC50, Ki, LD50, Quantitative Structure Activity/Property/Toxicity Relationship

Studies: 2D & 3D QSAR, Training & Test Data sets, validation, Pharmacophore Modelling: Pharmacophore definition and classes (HBA, HBD, Aromatic etc.), Identification of pharmacophore features, Building 2D/3D pharmacophore hypothesis, Searching databases using pharmacophores, receptor-based pharmacophores, Shape-based screening. Approaches & various phases of novel drug discovery, Clinical trials.

## List Of Elective Syllabus

### Artificial Intelligence

**Introduction:** Why AI, Importance of AI, LISP, Prolog and other programming language fore AI.

**Search strategies:** Representation Scheme, Blind Search technique, Heuristic Search technique, algorithm, monotone restriction – Specialized production systems – AO\* algorithm,

**Searching game trees:** Minimax procedure, alpha-beta pruning - Introduction to predicate calculus – Resolution refutation systems – Answer extraction,

**Knowledge representation, reasoning:** Knowledge representation, Knowledge acquisition, Logical Representation scheme, Procedural representation scheme, network representation scheme, STRIPS robot Problem solving system, Structured representations of knowledge (Semantic Nets, Frames, Scripts) KRR system, KR language, Domain modeling, Semantic net.

**Natural language processing:** An Introduction to Natural language Understanding, Perception, Learning.

**Applications of Artificial Intelligence:** AI in E-commerce, AI in E-tourism, AI in Industry, AI in Medicine.

#### Text Books:

1. Introduction to Artificial Intelligence by Rajendra Akerkar, PHI
2. Introduction to Artificial Intelligence by Eugene Charniak, Pearson Education
3. Artificial Intelligence by Rich & Knight, Tata McGraw Hills.
4. Introduction to Artificial Intelligence & Expert system by Dan W. Patterson PHI

#### Reference Books:

1. Artificial Intelligence: A Modern Approach by Stuart Russell, Peter Norvig, and Pearson Education.
2. Introduction to Expert System, Peter Jackson, Pearson Education.
3. Artificial Intelligence application programming by M. Tim Jones, Dreamtech Press

### Web Programming/Internet Programming

**Database Connectivity :** Concept of JDBC (Java Database Connectivity), working with SQL, Stored Procedures.

**Client Server Side Programming :** Java Script- Introduction, data types, variables, operators, Array Objects, Date, Objects, String Objects, Document Object Model, Image Object, Event handling, Browser Object, Window Object, Location Object, History Object, Submit event and data validation. Understanding Servlet programming, its Life- Cycle, Servlet Configuration, understanding Servlet sessions understanding of JSP and JSLT, JSP documents, Elements, tag extensions, tag libraries, validation, translation time mechanism translation- time classes, Understanding Java Server Pages Standard Tag Library, tags in JSLT, core tag library, XML tag library using Internationalization Actions.

**J2EE :** Advantages of J2EE, Enterprise Architecture Types, Understanding EJB, its architecture, EJB Roles, Benefits and limitations of Enterprise beans, session beans: Stateful and Stateless beans, Entity Beans, Beans Managed Persistence, Container Managed Persistence, Introduction to Web Containers.

**Network Programming :** Java Socket programming for TCP and UDP, RMI (Remote Method Invocation).

**Case Study :** Web Applications, Web Applications Life Cycle, Enterprise Application Development process, Deploying Web Applications.

**Text Books:**

1. Java Server Programming J2EE, 1.4 Edition Black Book (Dreamtech Press)
2. Core Java TM Volume II by Cay S. Horstmann & Gray Cornell (Pearson)

**Reference Book:**

1. J2EE 1.4 Bible by McGovern (Wiley India)

## Discrete Mathematics

**Set, relation and function**

Basic operation on sets, Cartesian product, disjoint union (sum), and power sets, Different types of relations, their compositions and inverses, Different types of functions, their compositions and inverses.

**Propositional logic**

Syntax and semantics, connectives, conditional & biconditional connectives Functionally complete sets of connectives, Two-state Devices and Statement Logic, satisfiability tautology, normal forms Predicate calculus

**Algebraic structure**

Algebraic structures with one binary operation – semigroup. Monoid and group, Congruence relation, Permutation group.

**Partially ordered sets**

Complete partial ordering, chain, lattice, Complete, distributive, modular, and complemented lattices, Boolean lattices, Sublattices.

**Introduction to Counting**

Basic counting techniques- inclusion and exclusion, pigeon-hole principle permutation, combination, partition & distribution

**Introduction to Graph**

Graphs and their basic properties- degree, regularity, subgraph, isomorphism, Connectedness-path & walk, circuits, cycles, component, connectivity, Bipartite graph, Tree, Kuruskal algorithm Prims algorithm, Eulerian and Hamiltonian graph, Graph colouring- vertex colouring, edge colouring planar graph.

**Text books:**

1. Discrete Mathematics – R. Manohar & Tremblay – McGraw-Hill Book Co.
2. Discrete Mathematics (For Computer Scientist)- John Truss - Pearson Education

**Reference Books:**

1. Discrete Mathematics – Richard Hohnson Baugh
2. Discrete Mathematical Structures – Bernard Kolmar, Robert C Busby, Sharon Cutter Ross
3. Discrete Mathematics – Nborman L. Biggs – Oxford University, USA
4. Discrete Mathematics and Structures – Satindre Bal Gupta – Laxmi Publication Pvt. Ltd.  
Set theory- S.N. Thakur

## Computer Networking

**Introduction:** Network Hardware & Software, OSI Reference Model, TCP/ IP Model, Comparison of the OSI & TCP/ IP model. **The**

**Physical Layer:** Guided Transmission Media, Physical Layer Standard.

**The Data Link Layer:** Need for Data Link Control, Service Provided by the Data Link Layer, Frame Design Consideration, Flow Control Mechanism. Data Link Error Control, in Stop-and –wait Mechanism & Sliding Window Mechanism, Sequence numbering, Piggybacking Acknowledgements, Data Link Management.

**MAC Protocols:** Random Access Protocols – ALOHA.

**IEEE 802.3 Ethernet:** Contention Access, CSMA, CSMA/CD, Physical Topology of Ethernet, Ethernet Repeater, Types of Ethernet.

**Bridges and Layer-2 Switches:** LAN Bridge , Transparent Bridges, Spanning Tree Algorithm, Source Routing Bridge, Route Discovery in Source Routing, Layer 2 Ethernet Switches,

**The Network Layer:** Network Layer Design Issue, Purpose of Network Layer, Functions of the Network Layer.

**Introduction to Internet Protocol:** IPv4 Format, ICMP.

**Routing Algorithms:** Static Routing, Dynamic Routing, Distance Vector Routing Algorithm, Routing Information Protocol, Link State Routing, OSPF Routing Protocol, Interior and Exterior Protocol, and Border Gateway Protocol.

**Introduction to Transport Layer:** TCP & UDP.

**Introduction to application Layer:** TCP/IP Application Protocol.

#### **Text Books:**

1. Data Communication & Networking by Forouzan, Tata Mcgraw Hill.
2. Computer Network, 4e by Andrew S. Tanenbaum, Pearson Education / PHI
3. Data Communication and Computer Networks, by Prakash C. Gupta, PHI
4. Networking All-In –One Desk Reference by Doug Lowe, Wiley Dreamtech

#### **Reference Books:**

1. Computer Networking: A Top-Down Approach featuring the Internet, 3e by James F. Kurose
2. Computer Network by Godbole, Tata Mcgraw Hill.
3. Computer Networking, by Stanford G. Rowe, Marsha L. Schuh

## **Perl**

Introduction: What is Perl? Why use Perl in Bioinformatics? History of Perl, Availability, Support, Basic Concepts Scalar Data: What Is Scalar Data? Numbers, Strings, Scalar Operators, Scalar Variables, Scalar Operators and Functions. Arrays and List Data: What Is a List or Array? Literal Representation, Variables, Array Operators and Functions, Scalar and List Context. Control Structures: Statement Blocks Hashes: What Is a Hash? Hash Variables, Literal Representation of a Hash, Hash Functions, Hash Slices, Basic I/O. Regular Expressions: Concepts about Regular Expressions, Simple uses of Regular Expressions, Patterns, more on the Matching Operator, Substitutions, the split and join Functions; Subroutines: System and User Functions, The local Operator, Variable-length Parameter Lists, Notes on Lexical Variables ; File handles and File Tests, File Manipulation, Directory Manipulation; Formatting Data: Sorting, Transliteration ; Database Manipulation: DBM Databases and DBM Hashes, Opening and Closing DBM Hashes, Fixed-Length Random-Access Databases, Variable-Length (Text) Databases, Win32 Database Interfaces; Bioperl: Introduction, Installation procedures, Architecture, Uses of Bioperl.

#### **Literature Recommended:**

1. Schwartz Randal L., Phoenix Tom. Learning Perl. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc.. ISBN: 8173663718
2. Moorhouse Michael, Barry Paul. Bioinformatics, Biocomputing and Perl: an introduction to bioinformatics computing skills and practice. Publisher: John Wiley and Sons, 2004. ISBN: 047085331XBal, H.P. Perl programming for Bioinformatics. Publisher: Tata McGraw-Hill New Delhi. 2003. 0070474478.
3. Curtis Jamison D. Perl programming for biologists. Publisher: John Wiley & sons, inc., 2003 ISBN 0471430595.
4. Tisdall James D. Beginning Perl for bioinformatics. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc. 2001 ISBN: 8173663955.

## **Programming with Python**

Introduction to python programming, Keywords & Identifier, Statements & Comments, Python Data Types (numbers, lists, tuples string and dictionary), Python I/O and Import, Python Operators and Operator Precedence, Conditional Statements if...else, for and while, loop, break and continue, Pass Statement, File Handling in python: File Operation (open, reading writing and closing of files), Directory handling, Use defined exception and it's handling. Python functions: syntax, function call, types of functions, function arguments, recursion, anonymous functions, python module and packages, import and reloading module, importing module from packages, Object & Class in python: defining an Object and class in python, Deleting attributes and objects, namespace and variable scopes, concept of python class, inheritance and method overriding, multiple inheritances, resolution order.

### Literature Recommended:

1. David M, Beazley DM (2009) Python Essential Reference (4th Edition). Pearson Addison-Wesley Professional
2. Downey AB (2009) Think Python: An Introduction to Software Design. Create Space Independent Publishing Platform
3. Lutz M (2009) Learning Python (5th Edition). O'Reilly

## Programming in Linux

Fundamentals of computers and software systems: Types of computers, Operating Systems, Languages, Computer Networks, Internet technology, Remote Login (telnet, ssh, ftp etc.), Web technology & Web Servers; File Management, Directories, File Permissions, Environment Setting; Basic Utilities commands: cp, mv, cd, ls, rm, clear, lp/lpr, cat, pwd; Pipe and Filters: Grep, SED, AWK; Processes; Compiling and Running the Source Code, Make and Make file ; Shell Programming and its execution: Basic Operators, if condition, Loop, Running of shell script; Introduction to programming Languages and Paradigms, Syntactic Structure, Semantics, Data Representation, Data Abstraction, Procedure activation, Structured Programming, Block Structuring

Procedural Languages, Object-oriented Programming, Functional Programming, Logic Programming

Basic concepts in Fuzzy Set theory – Operations of Fuzzy sets – Fuzzy relational equations –Propositional, Predicate Logic – Inference – Fuzzy Logic Principles – Fuzzy inference – Fuzzy Rule based systems – Fuzzification and defuzzification – Types.

Fuzzy logic controllers – Principles – Various industrial Applications of Fuzzy logic control–

Adaptive Fuzzy systems – Fuzzy Decision making – Fuzzy classification – Fuzzy pattern Recognition – Image Processing applications – Fuzzy optimization. Fundamentals of Neural networks – Neural network architectures – Learning methods –Taxonomy of Neural Network Architectures – Standard back propagation Algorithms – Selection of various parameters – Variations

Associative memory – Exponential Bidirectional Associative Memory – Adaptive Resonance

Theory – Introduction – Adaptive Resonance Theory 1 – Adaptive Resonance Theory 2 –Applications – Kohen Self organizing maps – counter propagation networks – Industrial Applications.

Fundamentals of Genetic Algorithms – Hybrid systems – Meta heuristic techniques like simulated Annealing, Tabu Search, Ant colony optimization, Perpetual self organizing, Artificial immune systems – Applications in Design and Manufacturing.

### REFERENCES:

1. S. Rajasekaran, GA VijayalakshmiPai, 'Neural Networks, Fuzzy Logic and GeneticAlgorithms', Prentice Hall of India Private Limited, 2003.
15. 2. Klir, G.J. Yuan Bo, 'Fuzzy sets and Fuzzy Logic: Theory and Applications', Prentice Hall ofIndia Pvt. Ltd., 2005.
16. 3. Simon Haykin, 'Neural Networks – A comprehensive foundation', Prentice Hall, 3rd Edition,2004.
17. 4. LaureneFausett, 'Fundamentals of Neural Networks, Architectures, Algorithms andApplications, Prentice Hall, Englewood cliffs, 2000.

## Big Data Analysis

Fundamentals of Big Data Analysis Environment:

Distributed and Parallel System Architecture and Configuration

In this lab, students will set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, students will configure a 3-node Hadoop cluster(one master and two slaves). This lab requires extensive system configuration knowledge and practices.

MapReduce on Word Counting

Hadoop MapReduce is a software framework for easily writing applications which process vast amounts of data (multi-terabyte data-sets) in-parallel on large clusters (thousands of nodes) of commodity hardware in a reliable, fault-tolerant manner. A MapReduce job usually splits the input data-set into independent chunks which are processed by the map tasks in a completely parallel manner. The framework sorts the outputs of the maps,

which are then input to the reduce tasks. Typically both the input and the output of the job are stored in a file-system. The framework takes care of scheduling tasks, monitoring them and re-executes the failed tasks. To get familiar with the MapReduce platform in Hadoop, a word counting program is used to convey the fundamental concept. Students will develop a working MapReduce application for word counting on Hadoop cluster.

## MapReduce on Word Counting

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## NoSQL

Relational schema format is not suitable for storing huge data volume in big data analysis processing any more, instead NoSQL MongoDB/HBASE is widely used as I/O storage for Hadoop to deliver complex analytics and data processing. Students can use it to pull your data into Hadoop Map-Reduce jobs, process the data and return results back to a NoSQL database collection. Students will have hands-on experience in convert unstructured data into NoSQL data and do all necessary operation such as NoSQL query with API.

## Machine learning and Reasoning with Mahout

Mahout supports mainly three use cases: Recommendation mining takes users' behavior and from that tries to find items users might like. Clustering takes documents and groups them into groups of topically related documents. Classification learns from existing categorized documents what documents of a specific category look like and is able to assign unlabelled documents to the correct category. Students will learn how to use Mahout machine learning library to facilitate the knowledge build up in big data analysis.