## Open electives offered by Department of Chemical Engineering

| III/IV B.TECH. I SEMESTER | IV/IV B.TECH. I SEMESTER |
|---|---|
| CHE 311(A) Industrial Safety and Hazards Management | CHE 411(A) Food Processing Technology |
| CHE 311(B) Engineering Biology | CHE 411(B) Corrosion Engineering |
| CHE 311(C) Fuel Cell Technology | CHE 411(C) Computational Tools for Engineers |
| CHE 311(D) Design of Experiments | CHE 411(D) Bioinformatics |

**OPEN ELECTIVE - I**

# INDUSTRIAL SAFETY AND HAZARD MANAGEMENT

**CHE 311(A)** **Credits:4**

Instruction :3 Lectures & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:** Engineering chemistry

**Course Objectives:**

1. To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models
2. To understand about fire and explosion, preventive methods, relief and its sizing methods
3. To analyse industrial hazards and its risk assessment.

**Course Outcomes:**

By the end of the course the students will be able to

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.
5. Understand the methods of hazard identification and preventive measures.

**CO –PO – PSO Matrix:**

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**SYLLABUS**

**UNIT I** **9 L+ 3 T**

**Introduction:** Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Seven Significant Disasters.

**Toxicology**: Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values, National Fire Protection Association (NFPA) Diamond.

**UNIT II** **9 L+ 3 T**

**Industrial Hygiene:** Government Laws and Regulations, OSHA: Process Safety Management, EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS) Industrial Hygiene: Anticipation and Identification, Evaluation, Control.

**Source Models**: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis

**UNIT III** **9 L+ 3 T**

**Fires and Explosions:** The Fire Triangle, Distinction between Fires and Explosions, Definitions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram, Ignition Energy , Autoignition , Auto-Oxidation , Adiabatic Compression, Ignition Sources, Sprays and Mists, Explosions

**Concepts to Prevent Fires and Explosions**: Inerting, Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Miscellaneous Concepts for Preventing Fires and Explosions.

**UNIT IV** **9 L+ 3 T**

**Introduction to Reliefs**: Relief Concepts, Definitions, Location of Reliefs, Relief Types and Characteristics, Relief Scenarios, Data for Sizing Reliefs, Relief Systems.

**Relief Sizing** : Conventional Spring-Operated Reliefs in Liquid and in Vapor or Gas Services, Rupture Disc Reliefs in Liquid in Vapor or Gas Services, Two-Phase Flow during Runaway Reaction Relief , Pilot-Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust and Vapor Explosions, Venting for Fires External to Process Vessels, Reliefs for Thermal Expansion of Process Fluids.

**UNIT V** **9 L+ 3 T**

**Hazards Identification:** Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews, Other Methods,

**Risk Assessment**: Review of Probability Theory, Event Trees, Fault Trees, QRA and LOPA

**Text Book:**

1. D.A. Crowl and J.F. Louvar, *Chemical Process Safety (Fundamentals with Applications)*, Prentice Hall, 2011.

**Reference Books:**

1. R.K. Sinnott, Coulson & Richardson's, *Chemical Engineering*, Vol. 6, Elsevier India, 2006.
2. Fawcett H.H. and W.S.Wood, *Safety and accident prevention in Chemical operations* 2nd editon John Wiley and Sons Inc. (1982).

**OPEN ELECTIVE - I**

# ENGINEERING BIOLOGY

**CHE 311(B)** **Credits:4**

Instruction : 3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:**

Differential Equations

**Course Objectives:**

1. To inculcate the fundamentals of life sciences with engineering application
2. To write mathematical models for antigen-antibody interactions
3. To predict infection by mathematical modelling

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Know the fundamentals of microbiology and application of mathematics to the growth of microorganims
2. Know the structure and properties of biomolecules
3. Understand the importance of immune cells and mathematical modelling of antigen-antibody interactions
4. Able to formulate the mechanism of enzyme- substrate kinetics
5. Able to write kinetic models by understanding the mechanism of the disease

**CO – PO – PSO Matrix:**

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## SYLLABUS

**UNIT I** **9 L+ 3 T**

**Introduction to Microbiology:**

Phylogeny of the three dimensions of life, ultra structure of bacteria, cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell, counting of microorganisms, sterilization, microbial growth kinetics,

**UNIT II** **9 L+ 3 T**

**Introduction to Biochemistry:**

**Carbohydrates biological functions:** General structure, monosaccharides, disaccharides and polysaccharides

**Proteins biological functions:** Amino acids, peptide bond, primary, secondary, tertiary and quaternary structure of proteins

**Nucleic acids biological functions:** Nucleotides, DNA structure and its properties, RNA structure and its properties,

**Lipids biological functions:** General structure, saturated and unsaturated fatty acids

**UNIT III**

**Introduction to Immunology:** **9 L+ 3 T**

Antigen-Antibody interactions, T-Cells (CD4 and CD8 cells), innate and adaptive immune response, autoimmunity

**UNIT IV** **9 L+ 3 T**

**Enzyme engineering:**

Definition of enzyme, classification of enzymes, enzyme-substrate kinetics, immobilization of enzymes, applications of enzymes in various industries and medicine

**UNIT V** **9 L+ 3 T**

**Viral Dynamics:**

Simple growth model, exponential growth and decay, predator-prey model, mathematical modeling of HIV dynamics in a human body

**Text books:**


1. James M. Lee., *Biochemical Engineering*, 1st edition, Prentice-Hall, International Series in the Physical and Chemical Engineering Sciences (**Unit 1, 2 and 4**)
2. Thomas. J. Kindt., Barbara A. O., Richard G., Kuby, *Immunology*, 6th edition, W. H. Freeman & Co (**Unit 3**)
3. Rob J. de Boer & Kirsten ten Tusscher, *Theoretical Biologyand Bioinformatics*, Utrech University (e-material) URL link: http://theory.bio.uu.nl/rdb/books/tb.pdf (**Unit 5**)


**Reference book:**


1. Pelczar, Jr. Michael, Chan E.C.S., Krieg R.N., *Microbiology*, 6th edition, Tata Mc Graw Hill, Education
2. David L. Nelson., Michael M. Cox, Lehninger, *Principles of Biochemistry*, 6th edition, W. H. Freeman & Co
3. J.D. Murray , *Mathematical Biology I: An Introduction*, 3rd edition, Springer

**OPEN ELECTIVE - I**

# FUEL CELL TECHNOLOGY

**CHE 311(C)** **Credits:4**

Instruction :3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:** Engineering Chemistry

**Course Objectives:**

1. To provide with a fundamental understanding of fuel cells and their applications.
2. To know the fuel cell components, electrocatalysis, mass transport and fuel cell efficiencies.
3. To impart the basic knowledge of the operating principles and reaction kinetics in a fuel cell.
4. To characterize a fuel cell and know about the hydrogen storage and safety measures to be taken for proper storage and maintenance.

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Demonstrate their understanding about a fuel cell and it's applications in automotives.
2. Develop various fuel cells by proper combination of the basic components involved to increase the performance of a fuel cell.
3. Calculate cell efficiencies of different fuel cells and know their performance.
4. Apply the reaction kinetics involved in the operation of a fuel cell for various applications.
5. Design a fuel cell and make provision for hydrogen storage and safety during its storage.

**CO – PO – PSO Matrix:**

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## Syllabus

**UNIT I** **9 L+ 3 T**

**Introduction to Fuel Cells:** Introduction –types of fuel cells – low, medium and high temperature fuel cell, working of a fuel cell, principles of electrochemical energy conversion, basic electrochemistry, fuel cells for automotive applications – technology advances in fuel cell vehicle systems.

**UNIT II** **9 L+ 3 T**

**Fuel Cell Components:** Electrolytes, catalysts, current collector/bipolar plate, exchange current, electrocatalysis, fuel cell charge and mass transport.

**UNIT III** **9 L+ 3 T**

**Fuel Cell Thermodynamics:** Gibb's free energy, reversible and irreversible losses, EMF of the hydrogen fuel cell , efficiency and fuel cell voltage , cell efficiency , gibbs free energy and ideal performance, nernst equation, effect of temperature, pressure, concentration on nernst potential, fuel Crossover , ohmic Losses , charge double layer , fuel cell equations and concept of electrochemical potential.

**UNIT IV** **9 L+ 3 T**

**Fuel Cell Reaction Kinetics:** Introduction to electrode kinetics, activation polarization-concept of electrochemical kinetics, reaction rate, surface coverage, activation polarization for charge transfer reaction, butler-volmer equation, tafel equation, ways to improve kinetic performance, concentration polarization - diffusion transport in electrodes - limiting current density, derivation, transport through flow channels (bipolar plate), ohmic polarization - ionic conductivity, electronic conductivity, current-voltage predictions.

**UNIT V** **9 L+ 3 T**

**Fuel Cell Characterization and Safety:** Ways of characterization, in-situ(Electrochemical impedance spectroscopy and cyclic voltammetry) and ex-situ characterization, current interruption technique, hydrogen production and storage, safety issues, cost issues and life cycle analysis of fuel cells.

**Text Book:**


1. Viswanathan, B and Aulice Scibioh, M., *Fuel Cells: Principles and Applications*., CRC Press, 2008.
2. O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, *Fuel Cell Fundamentals*, Wiley, NY 2006.


**Reference Books:**


1. Basu, S.,*Fuel Cell Science and Technology*, Springer, N.Y., 2007.
2. Liu, H., *Principles of fuel cells*, Taylor & Francis, N.Y., 2006.
3. M.T.M. Koper (ed.), *Fuel Cell Catalysis*, Wiley, 2009.

**OPEN ELECTIVE - I**

# DESIGN OF EXPERIMENTS

**CHE 311(D)** **Credits:4**

Instruction :3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:** Engineering mathematics

**Course Objectives:**

1. To Uses of statistics in experimentation;
2. To understand role of experimentation in new product design, process development, and process improvement.
3. To analyse the result from investigations to obtain conclusions for economic designs
4. To become Familiar with methodologies which can be used in conjunction with experimental designs for robustness and optimization.

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Understand the statistical concepts used in design of experiments.
2. Analyze the experiments and discover the effects.
3. Design and confound the two level experiments.
4. Design and confound the three and mixed level experiments
5. Estimate the parameters using regression models.

**CO – PO – PSO Matrix:**

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## Syllabus

**UNIT I** **12 Periods**

**Introduction:** Strategy of experimentation, basic principles, guidelines for design of experiments, history of static design.

**Simple comparative experiments**: Basic statistical concepts, sampling and sampling distributions, interferences about the differences in means, randomized designs, paired comparison designs, interference about the variances of normal distributions.

**UNIT II** **12 Periods**

**Single factor experiments**: Analysis of variance and fixed effect model, model adequacy checking, practical interpretation of results, sample computer output, determining sample size, discovering dispersion effects.

Randomized complete block design, Latin square design, Graeco Latin square method

**UNIT III** **12 Periods**

**$2^k$ factorial design:** Introduction, $2^2$, $2^3$ and $2^k$ design, single replicate of the $2^k$ design, addition of center points to the $2^k$ design.

**Confounding and blocking in factorial designs**: Blocking a replicated $2^k$ factorial design, confounding in the $2^k$ factorial design, confounding in the $2^k$ factorial design in two and four and $2^p$ blocks, partial confounding.

**UNIT IV** **12 Periods**

**Fractional factorial designs two-level**: One-half fraction of the $2^k$ design, one quarter fraction of the $2^k$ design, general $2^{k-p}$ fractional design.

**Three-level and mixed-level factorials and fractional factorials**: $3^k$ factorial design, confounding $3^k$ factorial design, fractional replication of the $3^k$ factorial design, factorials with mixed levels.

**UNIT V** **12 Periods**

**Regression models:** Estimation of the parameters in linear regression models, hypothesis testing parameters in multiple regressions, confidence in intervals in multiple regression, prediction of Newton response observations, regression model diagnostics, testing for lack fit.

Response surface methodology, parameter optimization

**Experiments with random factors:** Random effect mode, two factorial with random factors, two factor mixed model, sample size determination with random effects, rues for expecyed mean squares, approximate F tests.

**Text Book:**

1. D.C. Montgomery, *Design and Analysis of Experiments*, 7th edition, John Wiley & Sons. Inc., 2013.

**Reference Books:**

1. C.F. Jeff Wu & Michael Hamada, *Experiments-Panning, Analysis, and Parameter Design Optimization*, 2nd edition, John Wiley & Sons. Inc., 2009.
2. R. L. Mason, R. F. Gunst & J.L. Hess, *Statistical Design and Analysis of Experiments with Applications to Engineering and Science*, 2nd edition, John Wiley & Sons. Inc., 2003.

OPEN ELECTIVE – II

# FOOD PROCESSING TECHNOLOGY

**CHE 411(A)** **Credits:4**

Instruction : 3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:**

Basic Biology, Basic Chemistry

**Course Objectives:**

1. To understand the fundamentals of food processing
2. To have an awareness of various unit operations in food industry
3. To know about the various handling and storage techniques of various foods

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Know the fundamentals of food microbiology and biochemistry
2. Outline the fundamental mechanical operations in food industry
3. Acquire knowledge on advanced processing in food industry
4. Understand the technology of manufacturing food products
5. Select different handling techniques suitable for food storage

**CO – PO – PSO Matrix:**

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## SYLLABUS

**UNIT I** **12 periods**

**Food Microbiology & Biochemistry:**

General aspects of food industry, Introduction to food microorganisms, association with food, sources and behaviour of food, factors effecting microbial growth and decay, thermal death kinetics, carbohydrates, proteins, lipids,vitamins-sources, nutrition value of food

**UNIT II** **12 periods**

**Food Processing Operations-I:**

Characteristics, cleaning sorting, and grading of food raw materials, Size reduction, size enlargement, mixing, emulsification, filtration, centrifugation

**UNIT III** **12 periods**

**Food Processing Operations-II:**

Extraction, Crystallization, drying, lyophilisation, microwave heating

**UNIT IV** **12 periods**

**Production of food products:**

Industrial production of beverages, non beverages products, dairy products, bakery, confectionery products and processing of vegetables, fruits and animal products

**UNIT V** **12 periods**

**Handling, Packaging and Storage of food products:**

Food spoilage, food quality control, Characteristics of packaging materials, manufacture of plastic films, coils, laminates, pouches, rigid plastic container paper, corrugated paper boards, shipping cartoons and containers

**Text books:**


1. Dennis. R. Heldmann., *Food Processing Engineering*, 3rd edition, Springer
2. D.G.Rao., Fundamentals of food engineering, 2002, PHI Learning Private Ltd


**Reference book:**


1. Michele Marcotte, Hosahalli Ramswamy, *Food Processing principles and applications*, 2005, CRC press
2. Gordon. L. Robertson, *Food Packaging : Principles and Practice*, 2006, CRC press

OPEN ELECTIVE – II

# CORROSION ENGINEERING

**CHE 411(B)** **Credits:4**

Instruction : 3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:**

Engineering Chemistry, Organic Chemistry

**Course Objectives:**

1. To know about corrosion, its effects and types of erosion
2. To acquire knowledge on mechanism of corrosion
3. To get acquaintance with corrosion testing methods
4. To have knowledge on anti-corrosive materials

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Analyze the factors for corrosion
2. Distinguish the various types of corrosion and their effects
3. Model mathematically the mechanism of corrosion
4. Determine the rate of corrosion and testing of corrosion
5. Propose anti-corrosive materials for different industries

**CO – PO – PSO Matrix:**

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## SYLLABUS

**UNIT I** **12 Periods**

**Introduction to corrosion:**

Definitions, Factors affecting the rate of Corrosion. Direct and indirect costs due to corrosion in Industrial practice, Corrosion rates determination from weight loss measurements. Electrochemical theories of Corrosion, EMF series, Galvanic Series their significance in corrosion monitoring, Corrosion Potential representation by Evans Diagrams, Polarization Over voltage, Activation and Concentration polarization, Nernst Equation and determination of Corrosion potentials. Thermodynamic aspects of Corrosion reactions- Potential-pH phase diagram for Iron Water system

**UNIT II** **12 Periods**

**Types of corrosion:**

Corrosion Cell –its components with examples –types of corrosion cells generally encountered-concentration cells, galvanic or dissimilar metal cells, temperature differentiation cells, Differential aeration cells. Forms of Corrosion-Uniform, Pitting, crevice corrosion, Cavitation erosion, impingement attack, Corrosion fatigue- metallurgical aspects affecting corrosion reactions Area effect, Grain boundary effect.

**UNIT III** **12 Periods**

**Mechanisms of corrosion:**

Dezincification, Intergranular Corrosion, mechanism and remedial measures, Stress Corrosion Cracking, Caustic embrittlement, Hydrogen embrittlement mechanism and remedial measures-mechanism of differential aeration corrosion and remedial measures. Biological corrosion due to bacterial habitat, Combination of two dissimilar metal electrodes and relevant current-potential diagrams to evaluate corrosion rates-galvanic Corrosion.

**UNIT IV** **12 Periods**

**Corrosion testing methods:**

Combating Corrosion – Corrosion testing methods: Weight Loss methods, standard expression for corrosion rates-Huey Test, Streicher Test, Warren Test for corrosion. Linear Polarization Technique to evaluate corrosion, interpretation of corrosion data by Nelson's Method. Corrosion Prevention Methods generally followed-Coatings, Organic (paints) and Inorganic coatings-Chemical Conversion coatings- Altering the environment, inhibitors organic and inorganic, altering or modifying the material, alloying essential design rules during fabrication and other precautions during the choice of the material for a given service environment. Passivity, Anodic Protection and Cathodic Protection, Sacrificial anode Method –Current impressed Method-galvanizing of steel.

**UNIT V** **12 Periods**

**Anti-corrosive materials:**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment. Ferritic, Austenitic steels and stainless steels-Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**Text books:**

1. Fontana. M.G, and Grene., *Corrosion Engineering*, 3rd edition, 2005, Tata McGraw Hill, New York.

**Reference Books:**

1. Uhlig. H.H., *Corrosion and Corrosion Control*, 3rd edition, 1985, John Wiley and Sons, New York.

OPEN ELECTIVE – II

# COMPUTATIONAL TOOLS FOR ENGINEERS

**CHE 411(C)** **Credits:4**

Instruction : 3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:**

Engineering Mathematics, basic knowledge on computer programming

**Course Objectives:**

1. To familiarize with MATLAB software to compute ordinary differential equations and integrations

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Know the basic syntax in MATLAB
2. Solve root finding problems using MATLAB
3. Solve interpolation problems using MATLAB
4. Solve numerical differentiation using MATLAB
5. Solve numerical integration using MATLAB

**CO – PO – PSO Matrix:**

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## SYLLABUS

**UNIT I** **12 Periods**

**Introduction to MATLAB:**

Basics of MATLAB, creating, saving and editing a script file, function file and plots, problems on matrix and vectors, matrix and array operations.

**UNIT II** **12 Periods**

**Root finding**

Root finding: bisection method, Newton's method, Secant method; least squares approximation.

**UNIT III** **12 Periods**

**Interpolation**

Polynomial interpolation, piecewise linear interpolation and cubic spline interpolation.

**UNIT IV** **12 Periods**

**Numerical differentiation:**

Ordinary differential equations: initial value problem: Euler and Runge-Kutta methods; boundary value problem: Finite difference method, shooting method, orthogonal collocation method.

**UNIT V** **12 Periods**

**Numerical integration:**

Numerical integration: mid-point, trapezoidal and Simpson's rule.

**Text books**

1. Rudra Pratap, *Getting started with MATLAB*, 2002, Oxford University Press

**References**


1. S. K. Gupta, *Numerical Methods for Engineers*, New Age Intl. Publishers 2nd ed., 2010
2. Jeffrey R. Chasnov, *Introduction to Numerical Methods,* Lecture notes, The Hong Kong University of Science and Technology.
3. B.S. Grewal, *Higher Engineering Mathematics.*,43rd edition, Khanna Publishers, New Dehli.

OPEN ELECTIVE – II

# BIOINFORMATICS

**CHE 411(D)** **Credits:4**

Instruction : 3 Periods & 1 Tut/Week Sessional Marks : 40

End Exam : 3 Hours End Exam Marks: 60

**Prerequisites:**

Basic Biology, Basic knowledge in computer programming

**Course Objectives:**

1. To use of computational tools to understand and analyse the biological data
2. To understand the design of novel drugs using computational tools
3. To predict new sequences using the existing sequences in databases

**Course Outcomes:**

By the end of the course, the student will be able to:

1. Understand the basics of bioinformatics
2. Know various types of databases to retrieve the protein sequence
3. Know various alignment methods to analyse biological data
4. Identify different strategies to predict biomolecules
5. Design novel drugs

**CO – PO – PSO Matrix:**

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## SYLLABUS

**UNIT I** **12 periods**

**History, Scope and Importance:**

Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities - internet basics- HTML - introduction to NCBI data model- Various file formats for biological sequences

**UNIT II** **12 periods**

**Databases -Tools and Their Uses:**

Importance of databases - Biological databases-primary sequence databases- Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases - structure databases - bibliographic databases - specialized genomic resources-analysis packages

**UNIT III** **12 periods**

**Sequence Alignment Methods:**

Sequence analysis of biological data-Significance of sequence alignment- pairwise sequence alignment methods- Use of scoring matrices and gap penalties in sequence alignments- multiple sequence alignment methods - Tools and application of multiple sequence alignment.

**UNIT IV** **12 periods**

**Predictive Methods Using Dna And Protein Sequences:**

Gene predictions strategies - protein prediction strategies - molecular visualization tools-phylogenetic analysis: Concept of trees- phylogenetic trees and multiple alignments.

**UNIT V** **12 periods**

Discovering a drug - target identification and validation - identifying the lead compound - optimization of lead compound - chemical libraries.

**Text books:**


1. T K Attwood, D J parry-Smith, *Introduction to Bioinformatics*, Pearson Education, 1st Edition, 11th Reprint 2005.
2. S.C. Rastogi, *Bioinformatics- Concepts, Skills, and Applications*, CBS Publishing, 2003.


**Reference Books:**


1. David W.Mount, *Bioinformatics sequence and genome analysi*, Cold spring harbor laboratory press, 2004.
2. S. Ignacimuthu, S.J., *Basic Bioinformatics*, Narosa Publishing House, 1995.