UNIVERSITY OF MUMBAI

No.UG/ 135 of 2005

CIRCULAR :-

A reference is invited to the Ordinances, Regulations and Syllabi relating to the Bachelor of Engineering (B.E.) degree course vide this office Circular No.UG/95 of 2004 dated 8th March,2004 and the Principals of the affiliated colleges in Engineering are hereby informed that the recommendation made by the Dean of the Faculty of Technology has been approved by the Academic Council at its meeting held on 5th February,2005 ***vide*** **item No.4.31** and that in accordance therewith the syllabus for the B.E.(Bio-Technology) (Semesters III, IV,V,VI, VII & VIII) degree course is as per ***Appendix*** and that the same will be brought into force with effect from academic year 2005-2006.

MUMBAI-400 032

12th April, 2005

for REGISTRAR

To,

The Principals of the affiliated colleges in Engineering

**AC/4.31/5.02.05**

**********

No.UG/ 135 -A of 2005. MUMBAI-400 032 12th April, 2005

Copy forwarded with compliments for information to :-

1) The Dean, Faculty of Technology
2) The Chairman, Board of Studies in Engineering (Bio-Technology)

for REGISTRAR

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information .

The Officer on Special Duty-cum-Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies ), Record Section (5 copies ), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies ), the Deputy Registrar, Statistical Unit ( 2 copies), the Deputy Registrar (Accounts Section),Vidyanagari (2 copies ) the Deputy Registrar, Affiliation Section ( 2 copies ), the Director, Institute of Distance Education,( 10 copies) the Director University Computer Center (IDE Building ), Vidyanagari, (2 copies ) the Deputy Registrar ( Special Cell), the Deputy Registrar,(PRO) , **the Assistant Registrar,**

4°31
5/2/05

## SCHEME OF INSTRUCTIONS AND EXAMINATION
## UNIVERSITY OF MUMBAI

COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: III

YEAR: S. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 3.1 | Applied Mathematics III (Chem) | 4 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| 3.2 | Applied Biochemistry | 3 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 3.3 | Applied Microbiology | 3 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 3.4 | Process Calculations | 3 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| 3.5 | Fluid Flow and solid Handling | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 3.6 | InformationTechnology and Data Management | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| | TOTAL | 19 | 12 | --- | | 600 | 100 | 50 | --- | 750 |

## SCHEME OF INSTRUCTIONS AND EXAMINATION
## UNIVERSITY OF MUMBAI

COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: IV

YEAR: S. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 4.1 | Applied Mathematics IV (Chem) | 4 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| 4.2 | Mass Transfer Operation | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 4.3 | Analytical Methods in Biotechnology | 3 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 4.4 | Molecular Genetics | 3 | --- | --- | 3 | 100 | --- | --- | 25 | 125 |
| 4.5 | Biomaterials & Components | 3 | --- | --- | 3 | 100 | 25 | --- | --- | 125 |
| 4.6 | Numerical Analysis, Modelling and Simulation | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| | TOTAL | 19 | 12 | --- | | 600 | 100 | 25 | 25 | 750 |

SCHEME OF INSTRUCTIONS AND EXAMINATION
UNIVERSITY OF MUMBAI
COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: V
YEAR: T. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 5.1 | Process Control Instrumentation | 3 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| 5.2 | Bioinformatics – I | 4 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 5.3 | Thermodynamics and Biochemical Engineering | 3 | --- | 2 | 3 | 100 | 25 | --- | 25 | 150 |
| 5.4 | Fermentation Technology and Bioconversion | 4 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 5.5 | Heat Transfer Operations | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 5.6 | Industrial Organisation and Management | 3 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| | TOTAL | 20 | 9 | 2 | | 600 | 100 | 25 | 25 | 750 |

SCHEME OF INSTRUCTIONS AND EXAMINATION
UNIVERSITY OF MUMBAI
COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: VI
YEAR: T. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 6.1 | Enzymes Engineering | 3 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 6.2 | Bioinformatics – II | 4 | 3 | --- | 3 | 100 | 25 | --- | --- | 125 |
| 6.3 | Immunology and Immunotechnology | 3 | --- | --- | 3 | 100 | --- | --- | 25 | 125 |
| 6.4 | Plant Cell and Tissue Culture | 4 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 6.5 | Bioreactor Analysis and Technology | 3 | --- | --- | 3 | 100 | --- | --- | --- | 100 |
| 6.6 | Genetic Engineering and Technology | 3 | --- | 2 | 3 | 100 | 25 | --- | --- | 125 |
| | TOTAL | 20 | 9 | 2 | | 600 | 100 | 25 | 25 | 750 |

SCHEME OF INSTRUCTIONS AND EXAMINATION
UNIVERSITY OF MUMBAI
COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: VII
YEAR: B. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 7.1 | IPR, Bioethics and Biosafety | 4 | --- | --- | 3 | 100 | 25 | --- | --- | 125 |
| 7.2 | Environmental Biotechnology-I | 4 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 7.3 | Bioseparation and Downstream Technology | 4 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 7.4 | Process Dynamics and Control | 4 | --- | --- | 3 | 100 | 25 | --- | --- | 125 |
| 7.5 | Elective – I | 4 | --- | 2 | 3 | 100 | 25 | --- | 25 | 150 |
| 7.6 | Project – A | --- | --- | 2 | --- | --- | 25 | --- | 25 | 50 |
| | TOTAL | 20 | 6 | 4 | | 500 | 150 | 50 | 50 | 750 |

Elective I: (1) Biomedical Engg. (2) Non-conventional Sources of Energy. (3) Protein Engg.

SCHEME OF INSTRUCTIONS AND EXAMINATION
UNIVERSITY OF MUMBAI
COURSE : B.E. (BIOTECHNOLOGY) SEMESTER: VIII
YEAR: B. E.

| Sr. No | Subject | Scheme of Instructions (1 Hour Periods) | | | Duration of Papers | Scheme of examination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Practical | Tutorial | | Theory Papers | Term work | Practical | Oral | Total |
| 8.1 | Transport Phenomena in Biotechnology | 4 | --- | --- | 3 | 100 | 25 | --- | --- | 125 |
| 8.2 | Environmental Biotechnology-II | 4 | 3 | --- | 3 | 100 | 25 | 25 | --- | 150 |
| 8.3 | Project Engineering | 4 | --- | --- | 3 | 100 | 25 | --- | --- | 125 |
| 8.4 | Process Plant Operations and Safety | 4 | --- | 2 | 3 | 100 | 25 | --- | 25 | 150 |
| 8.5 | Elective – II | 4 | --- | 2 | 3 | 100 | 25 | --- | 25 | 150 |
| 8.6 | Project – B | --- | 6 | --- | --- | --- | 50 | --- | 50 | 100 |
| | TOTAL | 20 | 9 | 4 | | 500 | 175 | 25 | 100 | 800 |

Elective-II: (1) Food Biotechnology (2) Metabolic Engg. (3) Agriculture Biotechnology

**Course: B.E. (Biotechnology)**
**Year: S.E. Semester III**
**Subject: 3.1 Applied Mathematics III**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

**Syllabus:**

1. **Complex Analysis:** **(10 hrs)**
   Analytic functions, Cauchy-Riemann equations, Cauchy integral formula and Cauchy's Residue Theorem (Statement and applications to real and complex integration problems no. proofs). Mappings, fractional linear transformations, fixed points, normal form, geometrical interpretations. Application to chemical engineering: Root locus.

2. **Laplace Transforms:** **(14 hrs)**
   Definition, properties of Laplace transforms (without proof). Convolution theorem (without proof). Methods of using tables of error functions, gamma function, Bessel functions and tables of Laplace and inverse Laplace transforms for solving differential equations. Applications to chemical engineering : (Formulations of these problems are not required, only a brief description of the physical system may be given) e.g. starting and operating a CSTR; heat conduction in a semi-infinite medium under various boundry conditions, oil field extraction, heat flow from a wedge shaped fin, counter current liquid-liquid extraction system, gas absorption column, laminar fluid flow in a cylindrical and rectangular duct, graphical solutions for second order reactions in CSTR.

3. **Bassels Equation:** **(14 hrs)**
   (No proofs required) Method of solving the equation and conditions for the four types of Bassel and modified Bassel functions. Properties of Bassel and Modified Bassel functions without proof. Applications to

chemical engineering: e.g. heat transfer from an extended surface.

4. **Numerical Methods:** (12 hrs)
   Numerical solutions of ordinary differential equations: Euler's method, predictor-corrector methods, Heun's method, modified Euler method, Runge-Kutta method of order 4 for one or more equations. Applications to chemical engineering: e.g. transient response of an adiabatic CSTR.

**References:**


1. Mickley, H.S., et al. Applied Mathematics in Chemical Engineering, Tata McGraw Hill, 1995.
2. Jenson V.G. and Jeffreys, G.V., Mathematical Methods in Chemical Engineering, Academic
3. Pushpavanam S., Mathematical Methods in Chemical Engineering, Prentice Hall of India. 1998.
4. Coughanour, Chemical Process Control, McGraw Hill International Edition, 1993.
5. Lipschutz S. Laplace Transforms, Schaum's Outline Series 1992.
6. Lipschutz S. Advanced Calculus, Schaum's Outline Series 1992.
7. Chapra Steven C. and Canale Raymond P. Numerical Methods for Engineers, McGraw Hill International Edition. 1990.

**Course: B.E. (Biotechnology)**
**Year: Semester III**
**Subject: 3.2 Applied Biochemistry**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | : 100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

**Syllabus:**

1) **Unit I** **[8 Hrs.]**
Structure and function of Biomolecules, Carbohydrates, proteins, Lipids and Nucleic acids . Biochemical sepataration and assay methods. Vitamins, Enzymes and coenzymes, Hormones.

2) **Unit II** **[8 Hrs.]**
Biological membranes and transport across them bioenergetics. Major anabolic and catabolic pathways, carbohydrate metabolism (Glycolysis, critic acid cycle, pentose phosphate pathway, galactose metabolism, electron transport and oxidative phosphorylatin, Gluconeogenesis).

3) **Unit III** **[8 Hrs.]**
Lipid metabolism (transport and oxidation of fatty acids in animal tissues , biosynthesis of lipids.)
Protein and nucleic acid metabolism ( outlines of amino acid metabolism , mechanism and biosynthesis of DNA and RNA , protein biosynthesis , transport of proteins and sitnal peptides)

4) **Unit IV** [8 Hrs.]
Photosynthesis. Typical metabolic pathways of microbes:Enter – Dudroff pathway, Glyoxylate cycle, phosphoketolase pathway.

5) **Unit V** **[8 Hrs.]**
Structural and functional studies of Myoglobin , Catalase , :Lysozyme, Calmodulin and Tubulin.

References:


1. I AL Lehninger, DL Netson , MM Cox Principles of Biochemistry, CBS Publishers and Distributors.
2. Lubert stryen Biochemistry , Freeman WH & Company, New York]
3. JH Weil, General Biochemistry, New Age International(P) Limited.1997.
4. David T. Plummer , An Introduction to practical Biochemistry , Tata Mc-Graw Publishing Company Ltd.


**Eight experiments of the following experiments are to be conducted:**

1. Estimation of carbohydrates
2. Estimation of proteins
3. Estimation of nucleic acids
4. Isoelectric precipitation
5. Separation of aminoacids by paper chroatography
6. Extration of lipids
7. Thin layer chromatography
8. Gel electrophoresis
9. Assay of enzyme activity and enzyme kinetics
10. Identification and estimation of an intermediate of ENP pathway
    Cell fractionation

**Course: B.E. (Biotechnology)**
**Year: Semester III**
**Subject: 3.3 Applied Microbiology**

| LOAD PER WEEK: | | |
|---|---|---|
| | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

**Syllabus:**

1) **Unit I** **[10 hrs]**
Growth, nutrition and reproduction, isolation and identification of microorganism pure cultures and their characteristics. Maintenance of cultures, culture techniques enumeration techniques.

2) **Unit II** **[10 hrs]**
Bacterial growth; synchronous and asynchronous. Pure culture, growth inhibitiory substances. Effects of environment; sporulation and cell differentiation. Application of Microbiology in food, industrial and medical fields.

3) **Unit III** **[5 hrs]**
Physical and chemical methods of control of microorganism.

4) **Unit IV** **[6 hrs]**
Strain development.

5) **Unit V** **[8 hrs]**
Application of microbiology in medical, chemical and food industries.

**References:**


1. Murray Moo young Comprehensive Biotechnology, 1st Vol
2. Peleczar, Microbiology, TMH Publication.
3. P. Tauro, K.K. Kapoor, K.S. Yadav An Introduction to Micribiology
4. Prescott, Harley and Kelvin – Microbiology, 2nd ed.
5. Roger Y. Stainer et al. – General Microbiology, 5th ed., PHI publication.
6. Schlegel H. G. – General Microbiology, 8th , ed.
7. U.P. Guts, Chick et al. Microbes and Engineering Aspects, Springer Verlag
8. Wistreich and Lechman – Microbiology, Macmilllan Co

**Following experiments to be conducted:**

1. Preparation of nutrient agar slants, Plates and nutrient broth and their sterilization.
   (Microwave Oven, Heating mantles, Fridge, Heating Oven, Tube racks)
2. Inoculation of agar slants, agar plate and nutrient broth
   (Incubators, Water bath, Laminar hood, dry heat sterilizer i.e. bead sterlizer)
3. Culture of microorganisms using various techniques.
   (Shakers i.e. Cooling and Open shaker)
4. Simple and differential staining procedures, endospore staining, flageller staining ,
   Cell wall staining, capsular staining, negative staining.
5. Bacterial colony counting.
   (Moist chambers, spirit lamps, slides, loops and microscopes, haemocytometer)
6. Observation of different vegetative, capsular and spore forms of bacteria and fungus
   Under various microscope).
7. Isolation of microbes from soil samples and determination of the number of colony
   Forming units.
   (U.V. spectrophotometer, Colony counter etc.)
8. Study of growth curve of E. Coli

**Course: B.E. (Biotechnology)**
**Year: S.E. Semester III**
**Subject: 3.4 Process Calculations**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

**Syllabus:**

1) Units and Dimensions; Conversion factors **(2 Hrs)**
2) Stoichiometric and Composition Relationship **(2 Hrs)**
   - Stoichiometric relations
   - Composition of mixtures and solutions
   - Density and specific gravity
3) Material Balance **(6 Hrs)**
   - The material balance
   - Solving material balance problems involving simultaneous equations
   - Solving material balance problems involving multiple subsystems
   - Recycle, Bypass and Purge calculations
4) Material Balance with chemical Reactions **(10 Hrs)**
5) Gases, Vapours, Liquids and Solids **(6 Hrs)**
   - Ideal Gas Law
   - Real Gas relationships
   - Vapour pressure of liquids
   - Humidity and Saturation
   - Material balance involving condensation and vapourization
   - Psychrometric charts
6) Energy Balances, Fuels and Combuwstion **(6 Hrs)**
   - Concepts and Units
   - Heat capacity
   - Calculation of Enrthalpy changes
   - The General Energy Balance
   - Energy Balance with Chemical Reaction

7) Unsteady State Material and Energy Balances **(4 Hrs)**
   - Problems on Material Balance
   - Problems on energy Balance

8) Material and Energy Balances via Computer Codes **(6 Hrs)**
   - Analysis of the degree of freedom
   - Flow-sheeting codes
   - Building blocks, stream partitioning, tearing and convergence; block concept
   - Incidence matrix, Occurrence matrix, Precedence matrix.

**Term work:** Journal carries 15 marks and Test carries 10 marks

**References:**


1. Stoichiometry – Bhatt, B.I.U., Vora S.M.; Tata McGraw; 30 Edition
2. Basic Principles and calculations in Chemical Engineering – D.M.Himmelblau, Prentice Hall of India Pvt. Ltd.; Sixth Edition
3. Process Calculation for Chemical Engineers – Edited by Ch. Durga Prasad Rao and D.V.S. Murthy : McMillan, 1 Edition.

**Course: B.E. (Biotechnology)**
**Year: Semester III**
**Subject: 3.5 Fluid Flow and Solid Handling**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I: SOLIDS AND THEIR HANDLING** [08]
Properties of solid, screening , industrial screening equipment, Determination of particle size, screen analysis, size reduction of solids, stages of reduction, operating variables, intermediate and fine size reduction, power requirement and mechanism.

Power driven machines: Crushers, Grinders and Conveyers.

2) **Unit II: Filtration** [08]
Flow of solids through fluids, Classification and sedimentation.
Theory, Continuous and batch equipments.

3) **Unit III: FLUID FLOW** [08]
- Properties of fluids.
- Fluid statics: Euler's equation, Hydrostatic law and Pressure Measurement.
- Transport of fluids, energy relationships, pipe fittings, minor losses in pipe flow.

4) **Unit IV: Flow measurements** [08]
Orifice meter, Nozzel and venturi meters, rotameter and pilot tube.

5) **Unit V: Pumping and compressing** [08]
Reciprocating pumps, Rotary pumps, Centrifugal pumps and blowers.
Introduction to fluidization.

References:

1. Introduction to Fluid Mechanics by Robert W. fox and Slan T. Mcdonald, John urley & sons, Ny. Fourth Ed.
2. Unit Operation in Chemical Engg., Mccable Smith Vth Ed.

**Course: B.E. (Biotechnology)**
**Year: S.E Semester III**
**Subject: 3.6 Information Technology and Data Management**

| | | | |
|---|---|---|---|
| LOAD PER WEEK: | Lectures | : | 3 Hrs. |
| | Practicals | : | 3 Hrs. |
| | Tutorials | : | --- |
| EVALUATION SYSTEM: | Theory Examinations | : | 100 marks (3 Hrs) |
| | Practical Examinations | : | --- |
| | Oral Examinations | : | --- |
| | Term work | : | 25 marks |
| | TOTAL | : | 125 marks |

**Syllabus:**

1) **Unit 1: Fundamental Concept of Information** [ Hrs]
Definition of information, Need of information, Quality of Information, value of information, concept of Information Entropy, Information Contents, Introduction to Information representation in Digital Media, Text, Images, graphics, Animation, Audio, Video etc. Elementary Concepts in Information. Preservence, Data Compression, Huffman Coding, Shannon Principles, Adaptive Compression, LZW coding, Text, Images compression, Introduction to JPEG, MPEG, MHEG and other IT Industry Standards.

2) **Unit II: Computer & basic network concepts** [ Hrs]
Computer Languages, Interpreters, Compilers, Dataflow diagram, 4GLs, Software Development Life Cycles, Software Coding, Testing, Software Maintenance, QA, ISO, CMM, Need for Data Transmission over distances, Types of Data Transmission, Media for Data Transmission, networking of Computers. Introduction of LAN and WAN, Network Topologies, Basic Concepts in Computer Networks, Client-Server Architecture, Introduction to advanced communication techniques, ISDN, ATM, Token based protocol, CSMA/CD, Mobile Communication.

3) **Unit III: Internet and web technologies** [ Hrs]
Hypertext Markup Language, DHTML, WWW, gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email, Basic Concepts in E Commerce, EDI, Electronic Payments, e cash, credit cards, debit cards, Cryptography & Safe Electronics Commerce, Public Key Cryptography, Digital Signatures, Network, security, Firewall.

4) **Unit IV: Elements of database management system** [ Hrs]
Data base system concepts and architecture, data models schemea and instances, data independence and data base language and interface, Data definition languages, DML, Overall Database Structure, ER model concepts, notation for ER diagram, mapping

constraints, Keys, Concepts of Super key, Candidate key, Primary key, Generalization, aggregation, reduction ER diagrams to tables, extended ER model, relationships of higher degree, Relational data model concepts, integrity constraints, Keys, domain constraints, referential integrity, assertions, triggers, foreign key, relational algebra.

**Unit V: Rdbms design & sql** **[ Hrs]**

Functional dependencies, normal forms, first, second and third functional personal normal forms BCNF, multivalued dependencies fourth normal forms Example DBMS Oracle 8, SQL, data definition queries and updates in SQL Basic architecture, data definition and data manipulation, ISQL, PL SQL, cursors, Triggers, Stored Procedures etc.

**References:**


1. Curtin, "Information Technology: Breaking News", TMH
2. Yadav, DS, "Foundation of Information Technlogy", New Age
3. Rajaraman, v. "Introduction to Computers", PHI
4. Nelson, "Data Compression", BPB
5. Majumdar & Bhattachrya, "Database Management System", Tata Mcgraw Hill
6. Korth, Silbertz, Sudarshan, "Database Concepts", McGraw Hill.
7. Elmasari, Navathe, "Fundamentals of Database Systems", Addision Wesley
8. Date CJ " An Introduction to Database System", Addision Wesley

**Course: B.E. (Biotechnology)**
**Year: S.E. Semester IV**
**Subject: 4.1 Applied Mathematics IV**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

Syllabus:

1. **Numerical Methods** [10 Hrs]
Numerical solutions of partial differential equations: Leibmann's method for the Laplace equation. Derivative boundary conditions. Explicit and implicit methods for the heat equation. Crank-Nicolson method. ADI method. Applications to chemical engineering: e.g. on e dimensional mass balance of a reactor.

2. **Fourier series** [ Hrs]
Full range & half range expansions over a bounded interval, orthogonality properties, Parseval's identity. All relevant formulas to be used without detailed mathematical proofs. Application to Chemical Engineering problems: E.g. unsteady state heat conduction in Cartesian and cylindrical coordinates. Formulations are not included. Solution methods to be studied with a brief description of the physical system.

3. **Vector Calculus** [10 Hrs]
Gradient divergence, curl, irrotational and solenoidal vector fields and physical interpretation. Green's throrem, Gauss' divergence theorem and stokes theorem to & stated and used without proof for vector integration.

4. **Matrices and vector algebra** [10 Hrs]
Vector spaces and linear transformation matrix of a linear transformation. Change of basis. Similarity. Eigenvalues and Eigenspaces. Algebraic and geometric multiplicities. Diagonalisable transformations. Characterstic and minimal polynominals. Cayley-Hamilton theorem; Jordan form (proofs are not expected). Polynominal functions of a matrix. Matrix

methods to solve elementary equilibrium reactions in series of the ty
A.

5. **Optimization** [10 Hrs]
Objective function & constrains. Maxima / Minima, Heshian mat
properties, Lagrange's multiplier method (for not more than t
constraints). Kulin-Tucker conditions.

References:


1. Mickley, H.S. et al., Applied Mathematics in Chemical Engineering T
McGraw Hill
2. Jenson. V.G. and Jeffreys. G.V., Mathematical Methods in Chemi
Engineering Academic Press 1970.
3. Pushpavanam, S., Mathematical Methods in Chemical Engineeri
Prentice Hall of India 1998.
4. Coughanour. D.R., Chemical Process Control, Second Edition. McGr
Hill International Edition 1993.
5. Lipschutz. S., Vector Analysis. Schaum's Outline Series
6. Lipschutz. S., Lindar Algebra. Schaum's Outline Series
7. Lipschutz. S., Advanced Calculus, Schaum's Outline Series
8. Chapra, Steven C., and Canale Raymond P. Numerical methods
Engineers, McGraw Hill International Edition 1990.

**Course: B.E. (Biotechnology)**
**Year: Semester IV**
**Subject: 4.2 Mass Transfer Operations**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

**Syllabus:**

1) **Basic principles of mass transfer:** Molecular diffusion in fluids, mass transfer. Coefficients, Interphase mass transfer.

2) **Humidification operations:** Vapour pressure, enthalpy, absolute humidity, dew point, etc. Unsaturated vapour gas mixtures.

3) **Gas absorption:** Countercurrent, cocurrent multistage and continuous contact operations.

4) **Distillation:** Entrainment, pressure drops, flooding, transfer coefficients and relative volatility. Macabe Thiele and Ponchon method for binary component distillation of azeotropes. Flash Vaporization and Muulticomonent distillation.

5) **Liquid extraction:** Concurrent and countercurrent operations in single and multistages, solvents extraction, triangular diagrams.

6) **Drying:** Batch and freexe drying, rotary dries. Surface vs diffusion controlled operations.

7) **Leaching:** Design of equipment for above operations.

References:


1. McCabe W.L., Smith J.C., Harriot P., 'Unit Operations of Chemical Engineering, 5/e, McGraw Hill International Ed, 1993.
2. Treybal R.E., Mass Transfer Operations', 3/e, McGraw Hill International Ed, 1980.
3. Coulson J.M., Richardson J.E., Backhurst I.R., Harker J.H., Coulson and Richardson's Chemical Engineering, 4/e, Pergamon press, Vol. 1 & 2, 1990.
4. Coulson J.M., Richardson J.F., Sinnot R.K., Coulson and Richardson's Chemical Engineering vol. 6, 2/e, Pergamon press, 1993.
5. Foust A.S. et al., "Principles of Unit Operations, 2/e, John Wiley & Sons, 1980.
6. Perry R.H., Green D., 'Perry's Chemical Engineer's Hand – book, McGraw Hill, 1984.
7. Walas S.M., Chemical Process Equipment Selection & Design, Butter worth Heinemann, 1990.
8. King C.J., 'Separation Processes", Tata McGraw Hill, 1974.
9. Chopey N.P., 'Handbook of Chemical Engineering Calculations, 2/e, McGraw Hill International Ed., 1994.
10. Mcketta J.J., Unit Operations Handbook, Vol. 1 & 2 Marcel Dekker, 1992.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester IV**
**Subject: 4.3 Analytical Methods in Biotechnology**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I:** **[10 hrs]**
Chromatography techniques- Adsorption, Affinity, Gel filtration, Partition, Ion-exchange, GLC, GC, HPLC, FPLC, TLC, RPC.

2) **Unit II:** **[10 hrs]**
Electrophoresis- Colloidal solutions of bioplymers and their electrochemical properties. Different methods of electrophoresis for proteins, nucleic acids, small molecular weight compounds and immunoprecipitates.
Peptide mapping and combination of electrofocussing and SDS-PAGE.

3) **Unit III:** **[9 hrs]**
Hydrodynamic properties; Viscosity and diffusion of biopolymers; Molecular weight determination, Osmotic pressure, Reverse osmosis and Donnan effect. Structure of biomembranes and their electrochemical properties, membrane potential; action ptential and propogation of impulse. Use of radioactive and stable isotopes and their detection in biological systems.

4) **Unit IV:** **[15 hrs]**
Introduction to principle and application of (a) Spectroscopic methods (U.V., Vis, IR, Fluorescence, ORD, CD and PAS 9b) NMR, ESR, Mass-spectrometry. Introduction to principle and working of light and electron microscopes. Automated analyzer for amino acids and Protein sequencer, peptide synthesizer and Nucleic acids synthesizer. Theory of lyophilization and its applications to biological systems. Rotars angle/vertical, zonal/ continous flow buoyant density centrifugaation. Ultra-centrifuge- principles and applications.

5) Unit V: [6 hrs]

Tracer Technique, definition, choice of tracer, types of tracers and production, preparing labeled compounds and their applications in biological systems.

References:


1. H. Gunzler- handbook of Analytical techniques- Wiley Publications.
2. H. J. Rehm and G. Reed, Biotechnology- Vol.3,4,5, Verlag Publishers
3. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication
4. Murray Moo-Young Comprehensive biotechnology-, Vol. II-latest ed., Pergan Publishers.
5. Westermeier –ElectroPhoresis in Practice, Wiley Publications.
6. Willard et al., -International Methods of Analysis- CBS Publication
7. Wilson and Golding, A Biologist's Guide to Principles & Techniques of Pratical Biochemistry, Cambridge university Press
8. Haissinskey – Nuclear Chemistry and its Applications


List of Experiments

1. Adsorption
2. Affinity of Biological substances
3. Gel Filtration
4. TLC
5. Ion- exchange
6. Molecular weight of protein (Electrophoresis)
7. Molecular weight of DNA/ Nucleic Acids (Gel Electrophoresis)
8. Electrofocussing SDS-PAGE
9. Reverse Osmosis
10. Action Potential
11. UV Spectrophotometer
12. Ultra-centrifuge
13. Viscosity of Polymers
14. Brookfield Viscometer
15. Tracer technique for preparing Labelled compound.
16. HPLC

**Course: B.E. (Biotechnology)**
**Year: Semester IV**
**Subject: 4.4 Molecular Genetics**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : 25 marks |
| | Term work | : --- |
| | TOTAL | : 125 marks |

Syllabus:

1) Mendelian Genetics
2) DNA
   - Biochemical Structure
   - DNA as a genetic material
   - DNA Replication

   Excision Repair
   Recombination
3) Transcription
   - Synthesis of RNA from template DNA strand.
   - Splicing of RNA transcript.

   Type of RNA, Structure and Function of mRNA, tRNA & rRNA
4) Translation
   - Genetic code
   - Biochemical basis of protein
   - Biosynthesis

   Post- translational modifications
   Protein targeting.
5) Gene Mutations
6) Chromosomal Aberrations
7) Polyploidy
8) Regulation of Gene Expression.
   - Gene expression and regulation in prokaryotes and eukaryotes.
   - Operon concept and operon models: lac, trp & his Operon
   - Regulation of gene expression during cell differentiation.

References:


1. Tom strachan Andrew P. Read., Human Molecular Genetics (2nd Edition), John Wiley
2. Suzanne B. Cassidy, Management of Genetic Syndrome (2nd Edition), John Wiley
3. Richard J. Reece, Analysis of Genes and Genomes, John Wiley
4. Louis – Marie Houdebine, Animal Transgenesis and Cloning, John Wiley
5. Alain Bernot, Genome Transcriptome and Proteome Analysis, John Wiley
6. D.Peter Sunstad, and Michael J. Simmons, Principles of Genetics (3rd Edition), John Wil

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester IV**
**Subject: 4.5 Biomaterials and Components**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** [6 Hrs]
Introduction to biometerials, Characterization of materials; mechnical properties; thermal properties; surface properties and adhesion.

2) **Unit II** [9 Hrs]
Various classes and forms of biomaterial-metals; alloysand composites, ceramic materials, polymeric materials.

3) **Unit III** [9 Hrs]
Structure and properties relationship of biological materials.

4) **Unit IV** [9 Hrs]
Biological interface and interaction; bilogical response to implants, biomaterials for soft tissue replacements.

5) **Unit V** [9 Hrs]
Biologically functional biometerials, testing and clearance of biomaterials and evaluation of arteries.

References:


1. David Cooney "Biomedical engineering Principles: An Introduction to Fluid, heat and mass transport process" Stock ships.
2. Metin Akay "Biomedical Signal Processing" Stock ships.

**Course: B.E. (Biotechnology)**
**Year: S.E. Semester IV**
**Subject: 4.6 Numerical Analysis Modelling & Simulation**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

**Syllabus:**

1) **Solution of Algerbic and Transcendental equations**

| | |
|---|---|
| The Bisection method | [1 Hr] |
| Newton Raphson method | [3 Hr] |
| Generalised method | |
| Mullers's method | [1 Hr] |
| Numerical integration | [1 Hr] |
| Trapezoidal rule | [1 Hr] |
| Simpson's 1/3 – Rule | [3 Hr] |
| Simpon.s 3/8 – Rule | |
| Piccard's method of Successive Approximation | [1 Hr] |
| Euler's method | |
| Error estimates for the Euler's method | |
| Modified Euler's method | |
| Range –Kutta method | [1 Hr] |
| Gauss-seidel method | [1 Hr] |
| Energy equation | [1 Hr] |
| Equations of motion | [1 Hr] |
| Transport equations | [1 Hr] |
| Equations of motion | [1 Hr] |
| Transport of state | [1 Hr] |
| Series of Isothermal constant heldup CSTRs | [2 Hr] |
| CSTRs with variable holdups | [2 Hr] |
| Nonisothermal CSTR | [2 Hr] |
| Batch Reactor | [2 Hr] |

2) **Heating phase, Cooling phase**

| | |
|---|---|
| Three CSTRs in series | [2 Hr] |
| Three CSTR system | [2 Hr] |

References:


1. Numerical Methods for Engineers –Seven C. Chapra , Raymond P. Canale, Tata Mc Graw Hill Publication.

2. Applied Numerical Methods for Engineers (Using MATLAB & C) Robert J. Schilling, Sandra L. Harris, Thomson Learning Publication.

3. Transport Phenomena, R.B. Bird, W.E. Stewart and E.N. Lightfoot, John Wiley and Sons.

4. Transport Phenomena – A Unified Approach, R.S. Brodsky and H.C. Hershey, Mc Graw Hill International Edition.

5. Pushpavanam S., Mathematical Methods in Chemical Engineering, Prentice Hall of India.

**Course: B.E. (Biotechnology)**
**Year: T.E. Semester V**
**Subject: 5.1 Process Control Instrumentation**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

Syllabus:

1) **Introduction:** [5 Hrs]

Typical controlled process and feedback process control system elements. Process Instrumentation Diagrams, Components of typical systems & their Definitions.

Analysis in time domain/ Laplace domain, Concept of transfer function Concept of stability, optimum control systems.

2) **Chemical Process Instrumentation:** [5 Hrs]

Instruments for measurement of temperature, Pressure, composition, level, flow in chemical process systems, with special reference to use in control systems. Sensors & Transducers for instrumentation.

3) **Final Control Elements:** [5 Hrs]

Valves & their types. Valve characteristics- inherent anf effective. Valves positioner, Control valve selection and sizing.

4) **Dynamics of systems, elements & components:** [5 Hrs]

Method of studying systems dynamics .Step, ramp, sinusoidal, pulse and impulse input techniques. Developments of transfer function.

First order system. Linearisation of non linear systems.

Second order systems- underdamped, overdamped and critically damped.
Systems in series – interacting and noninteracting manner.

5) **Principle of Controls:** [5 Hrs]

Proportional, Integral, Derivative models of control and their combinations, Advantages & Disadvantages.
Open and closed loop study of controlled system dynamics. Negative feedback control system.
Pneumatic and electronic Controllers- their construction and operational characteristics, merits and demerits.

6) **Stability analysis of controlled systems:** [5 Hrs]

Routh's stability criterion
Introduction to Root Locus Analysis
Frequency Response Analysis – bode and Nyquist stability criteria.
Controller tuning – Gain & phase Margin, Methods of Controller tuning for optimization with respect to stability and other error criteria.
Complex Control Strategies sush as feed forward, cascade, adapter, supervisory, multivariable controls and their applications for optimum control.

7) **Principle of digital control:** [5 Hrs]

Fundamentals of digital Controls
Computer interfacing, D/A & A/D converters.
Direct Digital controls, Distributed Control Systems and Plantwise Control System.

8) **Application:** [5 Hrs]

Examples of systems for control of pumps, compressors, heat exchangers, distillation columns, Reactors etc.

Term work

Term work marks are distributed as follows

Practical work/ Journals/ Termwork : 15 Marks
Mid Term Test/ Examination : 10 Marks
==========
Total : 25 Marks

The practical will consist of any seven of the following experiments distributed equitably with respect to the syllabus.

- Dynamics of temperature measuring system
- Dynamics of tank level in flow system
- Dynamics of concentration change in an agitated tank
- Dynamics of second order system – underdamped, overdamped
- Dynamics of first order systems in series noninteracting interacting
- On Off controller
- Proportional controller
- Proportional + integral controller
- Proportional + integral controller + Derivative controller
- Tuning of P, I & PID controllers.
- Stability / Instability of control systems.

**References:**


1. Stephanopoloulos G. "Chemical Process Control- An introduction to Theory & Practice" Prentice Hall Of India Ltd., EEE, 1990.
2. Coughnowr, Koppel, "Process Systems Analysis and Control" 2/e, McGraw Hill, New Delhi, $ 10
3. Partranabis D., "Principles of Industrial Instrumentation" Tata McGraw Hill, 2/e, 1995, RS 100
4. Patranabis D., "Principle of Process Control" Tata McGraw Hill, 2/e, 1996, Rs100
5. Jones, "Instrumentation Measurement and Feedback, TMH 1978.
6. Nakra B,C., Chaudhary K.K., "Instrumentation Measurement and Analysis., THM, 1985.
7. Marlin, T,E, "Process Control – Designing Process and Control System for Dynamic Performance".
8. Shinsky "Process Control System Application" 3/e, McGraw Hill, 1975 $ 11
9. Considine " Process/ Industrial Instruments and Control handbook" 4/e McGraw Hill, 1993.
10. Liptak
11. Coomds, C.F., "Electronics Instruments Handbook" 2/e, McGraw Hill, 1993

Course: B.E. (Biotechnology)
Year: Semester V
Subject: 5.2 Bioinformatics I

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** [6 hrs]

What is bioinformatics, and why study it? How is large-scale molecular biology data generated, where and how can researchers gain access to it, and what is the quality of data? Private and future data sources. Metadata: Summary and reference systems, finding new types of data, likely growth areas.

2) **Unit II** [10 hrs]

Nucleotide sequence data: Genomic sequencing, expressed sequence tags, general expression, transcription factor binding sites and single nucleotide polymorphism Computational representations of molecular biological data storage techniques: database (flat, relational and object oriented), and controlled vocabularies. General data retrieve techniques: INDICES, Boolean search, fuzzy search and neighboring.

3) **Unit III** [10 hrs]

Biological datatypes and their special requirements: sequences, macromolecular structures, chemical compounds, genetic variability, and connections to clinical data. Representations of patterns and relationships: alignments, regular expression hierachies, and graphical models (including Markov chains and Bayes notes).

4) **Unit IV** [4 hrs]

Visualization: methods for presenting large quantities of biological data, particular sequence viewers, 3D structure viewers, anatomical visualization, and database drive web sites.

5) **Unit V** **[5 hrs]**

Interoperability: the challenges of data exchange and integration: ontologies, interchange languages and standardization efforts. XML, UMLS, CORBA, PERL, PYTHON, OMG/Life Sciences.

6) **Unit VI** **[10 Hrs]**

Inference problems and techniques for molecular biology. Overview of key inference problems in biology: homology identification, genomic sequence annotation, protein structure prediction, protein function prediction, gene expression characterization, network identification and drug discovery.

7) **Unit VII** **[5 Hrs]**

Overview of key computational induction techniques for density estimation, clustering, discrimination and regression. Statistical inference: significance: significance testing, regression, Bayes' rule, dimensionality reduction.

**References:**


1. Developing Bioinformatics. Computer Skill-O'Reilly, 1st Indiamn Edition, publication
2. An Intro. To Genetic Analysis-Anthony J.F.Griffiths et al.; Ed.
3. Gneomics Protocols-Michael Starkey and Ramnath Elaswarapu
4. Bioinformatics-Methods and Protocols-Stephen Misner & Stephen Krawetz
5. Lawrence Hunter-Arteficial Intelligence & Molecular Biology, free on web
6. DNA & Protein Sequence Analysis – A Practical Approach IRL Press at University Press.


**Following experiments to be conducted:**

1. Construction of database for specific class of proteins/enzymes, genes/ORF/EST/ Promoter sequences/ DNA motifs or protein motifs using oracle.
2. Access and use of different online protein and gene alignment softwares
3. Gene finding related search for a given nucleotide sequence in order to predict the gene.
4. ORF prediction for different proteins out of some given nucleotide sequences.
5. Exon identification using available softwares for a given nucleatide sequences.
6. Secondary structure prediction for amino acid sequences of a given protein.
7. *In silico* gene identification/characterzation in a prokaryotic organism using suitable annotation tools.
8. Secondry structure determination of a protein molecule using various tools.

**Course: B.E. (Biotechnology)**
**Year: Semester V**
**Subject: 5.3 Thermodynamics and Biochemical Engineering**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

**Syllabus:**

1) **Unit I** **[10 Hrs]**

Internal energy, formulation of First law of Thermodynamics, the thermodynamics state and State functions, Enthalpy, the steady state flow process, the reversible process, heat capacity and specific heat. Thermodynamics identities, Effect of pressure and Volume changes on Heat Capacities. Unsteady flow process. Constant colume process, constant changes on Heat Capacities. Unstaedy flow process, adiabatic process, polytropic process and their application to ideal and non-ideal gases.

2) **Unit II** **[10 Hrs]**

The PVT behaviour of pure substance, equation of state for gases, the principle of corresponding state, Gas mixtures. Mixtures of ideal gases, Dalton's law of additive pressure, Amagat's law of additive volume, the pseudo Critical Point Method.

Heat capacities of gases as function of temperature, specific heats of liquids and solids, heat effects accompanying phase changes, the srtandard heat combustion, effects of temperature on standard heat reaction, the heat effect of mixing process, Adiabatic flame temperature.

Relations among thermodynamic properties, Maxwell's Relation, clapeyorn two phase region, Geneaalized correlation of thermodynamic properties of gases.

3) **Unit III** **[10 Hrs]**

Statement of the second law of themodynamics, the concept of entropy, mathematical statement of the second law. Entropy changes and irreversibility, lost work "Clausicus inequality". Availablity, Second law analysis of steady and unsteady flow systems.

4) **Unit IV** **[10 Hrs]**

Bioenergetic principles and ATP cycle: Occurrence and properties of ATP, ADP and AMP, Free energy, the Standard free energy changes of chemical reaction, exergonic and endergonic reactions, Calculation of ultimate standard free energy change in biochemical reaction, Additive nature of Standard free energy change.

5) **Unit V** **[10 Hrs]**

The standard free energy of hydrolysis of phosphate compounds, The standard free energy of hydrolysis of ATP, Conditions affecting the standard free energy change of hydrolysis of ATP, the transfer potential of the phosphate group, Enzymatic transfers of phosphate groups to ADP, Transfer of Phosphate groups from ATP to various acceptors Dynamic of Phosphate group turnover in the cell, energetics of open system.

References:


1. Van Hess Smith " Anintroduction to Chemical Engineering Thermodynamics"
2. Cengal and Biles " Thermodynamics: An Engineering Approach"

**Course: B.E. (Biotechnology)**
**Year: Semester**
**Subject: 5.4 Fermentation Technology and Bioconversion**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** [5 Hrs]
History and development of fermentation industry: Introduction to submerged and solid state fermentation, Primary and secondary metabolite.

2) **Unit II** [5 Hrs]
Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crab tree effect, feedback inhibition and feedback repression.

3) **Unit III** [5 Hrs]
Procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. Isolation and preservation of different types of mutants-induction resistant, feedback inhibition resistant. Concept for overproduction of metabolites.

4) **Unit IV** [5 Hrs]
Industrial product formation through different microbial processes. General aspects, raw materials: Availability, proceses and pretreatment, medium preparation.

5) **Unit V** [5 Hrs]
Principles of upstream and down stream processing: small scale, medium scale and large scale processes, methods of inoculation and medium preparation, slurry processing and product isolation.

6) **Unit VI** [5 Hrs]
Fermentative production of organic acids: Lactic acid, Citric acid and Acetic acid. Fermentative production of enzymes: Proteases, Lipases and Amylases.

7) **Unit VII** [5 Hrs]
Fermentative production of biofertilizers i.e. rhizobium, BGA; Biopesticide i.e. Bacillu thuringienesis, Single Cell protine 9SCP) and Baker's yeast.

8) **Unit VIII** [5 Hrs]
Fermentative production of Antibiotics: penicillin, streptomycin, tetracycline and cephalosporin. Production of vitamins like Vitamin $B_{12}$; amino acids i.e. L-glutami acid, phenylalanine and L-lysine.

9) **Unit IX** [5 Hrs]
Fermentative production of organic solvents i.e. ethanol, Butanol and Acetone. Alcoholic beverages i.e. Beer, Wine, Rum, Gin, Whisky and Brandy.

10) **Unit X** [5 Hrs]
BiotransformationSteriod transformation. Important products through r-DNA technology: hepatitis B vaccines, interferon, insulin, somatotrophic hormone. Production of biosurfactants, biopolymers like xanthan gum and dextrin. Bioprocess Economics.

<u>References:</u>


1. A Lel and Kotlers richard J. Mickey, Microbes & Fermentation, Oriffin Publication
2. Aib, Humpherey & Miller, Biochemical Engg., Academic Press.
3. Leland, Industrial Fermentations-N.Y.Chemical Publishers.
4. Murray Moo-Young, Comprehensive Biotechnology, Vol. 1 & III latest ed.
5. Prescott and Dun's – Industrial Microbiology, 4th , ed.
6. Rehm, Reed & Weinheim, Biotechnology Series, Verlag-Cheiie Publication.
7. Wang & Humphrey, Fermentations & Enzyme technology Wiley & Inter Series.
8. A.Lel and R.J.Mickey- N.Y. Industrial Fermentations- Chemical Publishers.
9. A.Len and Richard J.Mickey, Microorganisms & Fermentation, Oriffin Publications.
10. Frazier, Food Microbiology, TMH ublishers.
11. Robert P. Onellette & Paul N, Application of Biotech- Cherin Siroff Lancaster
12. Prescott and Donn, Industrial Microbiology.

**Eight Experiments of the following experiments to be conducted:**

1. Study of induction effect of galactosidase enzyme in E.coli.
2. fermentation of ethyl alchohol using Candida albicans.
3. Fermentation of citric acid using Aspergillus niger
4. Creation of auxotrophic mutants for lysine, valine and other essential amino acids.
5. Designing of fermentation processes for penicillin and 6-APA.
6. Designing of fermentation process for lysine
7. Yeast fermentation to produce ethanol.
8. Fermentation of Pencillium crysogenum to produce pencillin.
9. Experimental design for the laboratory scale production of primary and secondary metabolites.
10. Design and construction of different type of laboratory bioreactors (batch, semi batch and continuos homogenous)
11. Design, construction and operation of immobilized cell bioreactor.

4) **Unit-IV** [08]

Heat Transfer Equipments

Classification, principle and design criteria, types of exchangers viz. Double pipe, shell and tube, plate type, extended surface, cooling tower etc. Furnaces and their classification and application, Simple calculations on them.

5) **Unit-V** [08]

Radiation & Evaporation

Basic laws of heat transfer by radiation, Black body and gray body concepts, View factors, Krichoff's law, Solar radiations, Combined Heat Transfer Coefficient by convection and radiation.

Elementary Principles, types of evaporators, Single and multiple effect evaporators and their calculation, thermocmopression.

**References:**


1. Holman, J.P. "Heat Transfer" McGraw Hill Books Co.
2. McAdams W.H. "Heat Transmission" McGraw Hill Books Co.
3. Kern D.Q. "Process heat Transfer" Mcgraw Hill books Co.
4. Bedger W.L. and Bancharo J.T. "Introduction to Chemical Engineering" Tata McGraw Publishing House.


**Laboratory:**

Experiments related to measurements of thermal conductivity, Shell and tube exchangers, Double pipe exchangers, Plate type heat exchangers, Nucleate and film boiling. Film-wise and drop-wise condensation, Heat pipe, Open pan evaporators, Long tube evaporators, Dryers.

**Course: B.E. (Biotechnology)**
**Year: T.E. Semester V**
**Subject: 5.6 Industrial Organisation and Management**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

Syllabus:

1) **Unit I** [3 Hrs]
Definition of Management
Different types of organisation
Industrial fatigue

2) **Unit II** [8 Hrs]

- Human resourse Development
  Personnel department / Labour welfare

Minimal wages for the employee
Labour union role and significance
Various types of labour unrest (Strike, gherao etc.)
Management –Labour union relationship Lockout
of the organisation

- Staff organisationm Design and system

Training department
Management information system:- EDP and DATA
management system

3) **Unit III** [3 Hrs]
Financial Management
Budgetory preparation systems,
Auditing systems
Balance sheet preparation

4) **Unit IV** [4 Hrs]
Material Management
Purchase, Store, inventory control

5) **Unit V** [3 Hrs]
Research and Development

6) **Unit VI** [4 Hrs]
Project Management/ Transfer

7) **Unit VII** [4 Hrs]
Marketing Management
Sales, product management distribution systems,
Medical services Management Board/Council

8) **Unit VIII** [3 Hrs]
Secretarial functions and Administration systems

<u>References:</u>


1. A.N.Agarwal, "Indian Economy".
2. Koonz and Odonnel, "Essentials of Management".
3. B.K. Chatterji, "Finance for Non-Finances Managers".
4. Prasanna Chandra, "Project Management".
5. Samuelson, "Economics".
6. Dewet and Warma, "Modern Economic Theory".
7. V.S. Ramaswamy, "Marketing Management".
8. Hampton David, "Management".

**Course: B.E. (Biotechnology)**
**Year: T.E. Semester VI**
**Subject: 6.1 Enzyme Engineering & Technology**

| | | | |
|---|---|---|---|
| LOAD PER WEEK: | Lectures | : | 3Hrs. |
| | Practicals | : | 3Hrs. |
| | Tutorials | : | --- |
| EVALUATION SYSTEM: | Theory Examinations | : | 100 marks (3 Hrs) |
| | Practical Examinations | : | --- |
| | Oral Examinations | : | --- |
| | Term work | : | 25 marks |
| | TOTAL | : | 125 marks |

Syllabus:

Unit I [4 Hrs]

Discovery classifications and nomenclature of enzymes. Enzyme isolation. Enzyme assay, Intracellular localization of enzymes. Isozymes, Multienzymes complex, and multifunctional enzymes.

UNIT II [4 Hrs]

Enzyme kinetics and kinetics of enzyme inhibition. Competitive, non-competitive and un-competitive inhibition of enzymes. Double reciprocal plots. Effect of PH, temperature, substrate and enzyme and inhibitors concentration on enzyme kinetics. Phenomena of allosterism and allosteric kinetics.

Unit III [4 Hrs]

Enzyme memory and pnemonical enzymes. Mechanism and action of chymotrypsin, glyceraldehyde, 3-phosphate dehydrogenase, lysozyme, carboxypeptidase, ribonuclease, aldolase and ribozyme.

Unit IV [4 Hrs]

Molecular structure and function of enzymes. Physico-chemical characterization of enzymes. Folding and active site formation in enzymes. Stability of enzymes: Enzyme stabilization by selection and genetic engineering, protein engineering, reaction environment rebuilding.

Unit V [4 Hrs]

Techniques used in the purification of the enzymes. Criteria of enzyme homogeneity, Techniques used for determination of native and sub-unit molecular weight of enzymes.

6) **Unit VI** [4 Hrs]
Various techniques of immobilization of enzymes.

7) **Unit VII** [4 Hrs]
Kinetics of immobilized enzymes including inhibition kinetics. Heterogeneous reaction systems: zero order & First order kinetics of concentration profile with reference to spherical geometry; Effectiveness factor; External & internal mass transfer; general comments on heterogeneous reactions in bioprocessing.

8) **Unit VIII** [4 Hrs]
Immobilized and native enzymes in reactor systems: retention and choice of enzyme reactor. Transient analysis of enzyme reactors. Classification of enzyme reactor with benzyl penicillin, deacylation, acyl- DL- amino acid optical resolution and starch conversion process as examples.

9) **Unit IX** [4 Hrs]
Process design and operation strategies of immobilized enzyme reactors. Operational problems; loss of performance with time. Parameters affecting the performance of enzyme reactors.

10) **Unit X** [4 Hrs]
Application of enzyme in industry : Food processing, Leather, Detergents, textile, Brevery, Pharmaceutical. Application of enzyme in medicine: Diagnosis, Analytical purpose and therapy.

**References:**


1. A.S. Bommarius et al., Biocatalysis: Fundamentals and Application- Wiley Publication.
2. D.J. Voet & J.G. Voet, 6th cd.Biochemistry
3. Hans Bisswanger, Enzyme Kinetics- Wiley Publication
4. Methods in Enzymology- A series
5. Murray Moo-Young Comprhensive Biotechnology, II & IV th Vol.
6. A.H. Rose- Microbial Enzymes & Bioconversions, Academic Press.
7. A.L. Lehninger- Biochemistry- Kalyani Publication
8. Aiba, Humphrey & Miller- biochemical Engg. Academic Press.
9. Chibata- Enzyme engineering
10. Dixon and Webb- Enzymes
11. Ed. H. V. Varley, A.H. Goven Lock and M. Bell William, Practical Chemical Biochemistry, Heinemann Medical Books Ltd. London..

12. Scorgy A.H. Biotech. For Engineering Biological systems in technological Process- Christopher Ellis Harwood Press
13. Srivastava & Murthy S, Heat & Mass Transfer- TMH publication.
14. Wangs & Humphrey- Fermentation & Enzyme Technology- Wiley International

**Following experiments to be conducted:**

1. Isolation of enzymes from microbial sources
2. Isolation of enzymes form plant sources.
3. Isolation of intracellular enzymes from microbial sources.
4. Determination of different kinetic parameters; Km, Vmax, activation energy, optimum Ph, optimum temperature using double reciprocal plots.
5. Determination of activation energy.
6. Subunit determination of enzymes.
7. Ammonium sulphate fractionation.
8. Purification of enzymes using sephadex and gel filtration coloum.

**Course: B.E. (Biotechnology)**
**Year: T.E. Semester VI**
**Subject: 6.2 Bioinformatics II**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | :--- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** [8 Hrs]
Machine learning: information theoretic decision tree induction, neural networks, the E/M algorithms, (including K-means clustering and filtering hidden markov mododels), genetic algorithms, simulated annealing, support vector machines, and the relation between statistics and machine learning. Evaluation of prediction methods: parametric tests, cross-validation and empirical significance testing.

2) **Unit II** [10 Hrs]
Overview of key computational simulation techniques: differential equation simulators, parameter estimation, and sensitivity analysis. Overview of key techniques for the management of large document collections and the biological literature: information retrieval, document clustering, and natural language information extraction.

3) **Unit III** [10 Hrs]
Advanced topics in bioinformatics. This course will address recent developments in bioinformatics and focus on advanced issues in specific areas including (but not limited to) information extraction from biomedical literature, inference of biochemical networks from high throughput data, and prediction of protein function.

4) **Unit IV** [8 Hrs]
Sequence abalysis- Analysis tools for sewuence datatbanks, pairwise alignment Needleman and Wunsch algorith, Smith waterman,

Multiple alignment- CLUSTAL, PRAS, BLAST, FASTA algorithm to analuze sequence patterns, motifs and profiles.

5) **Unit V** **[8 Hrs]**
Protein secondary structure predictions; prediction algorithms, Chao-fosman algorithm, Markov chain based algorithm, Artificial Neural Network based algorithm and softwares.

6) **Unit VI** **[10 Hrs]**
Protein databases and their classification, their fold libraries; Fold recognition (threading), protein structure predictions: comarative modelling (homology based), abinitio protein folding, protein ligand interactions.

7) **Unit VII** **[8 Hrs]**
Molecular modelling, dynamics and drug design.

8) **Unit VIII** **[4 Hrs]**
regulatory genomics and DNA chip.

**References:**


1. AD Baxevanis, Bioinformatics: a Pratical Guide to the Analysis of Genes & Proteins, 2nd ed.- Wiley Publications.
2. Lengauer, bioinformatics: From Genomes to Drugs- Wiley Publications.
3. Mj Donn, From Genomes to Proteome: Advances in the Practice and Application of Proteomics Wiley Publications.
4. Salzberg S.L. et al., Computational Methods in Biotechnology-Elsevier Science.
5. Evens & Grants, Statistical Methods in Bioinformatics-Springer-Verlag, NY.
6. MJE Sternberg, Protein Structure Prediction-A Practical Approach, Oxford University Press.
7. Setubal and Meidanis, Computational Molecular Biology-PWS publishing Co. 1997.

**Following experiments to be conducted:**

1. Comparative assesment of best available tools for gene annotation.
2. Development of a gene finding program using statistical significance and c++/c/Perl etc.
3. Establishment of methods for gene and protein phyllogeny by taking specific examples.

Course: B.E. (Biotechnology)
Year: Semester VI
Subject: 6.3 Immunology and Immunotechnology

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : 25 marks |
| | Term work | : --- |
| | TOTAL | : 125 marks |

Syllabus:

1) Unit I [8 Hrs]
Origin and introduction of immunology, inherent immunity, humoral and mediated immunity: primary and secondary lymphoid organ; B cell, T cell and macrophages; major histocompatibility complex (MHC).

2) Unit II [8 hrs]
Antigen processing and presentation; synthesis of antibody and secretion, complement; molecular basis of antibody diversity, polyclonal and monoclonal antibody, complement system, antigen and antibody reaction.

3) Unit III [6 hrs]
Regulation of immune response, immune tolerance, hyper-sensitivity; autommunity, DNA typing, auto-immune diseases, immnudeficiency and immunoproliferative deseases.

4) Unit IV [10 hrs]
Animal cell culture: Kinetics of mammalian cell growth; permanent cell lines and product formation. Reactors for large-scale culture of animal cells. Production of polyclonal antibodies with different types of antigens: antigen preparation, adjutants and dose of antigens, collection of sera, purification of antibodies.

5) Unit V [8 hrs]
Hybridoma cell technology – production and application of monoclonal antibodies. Production of virus vaccines, specific vaccines, recombinant vaccines. Production of cellular chemicals likes interferons, interleukins etc. Immunoassay procedures.

**References:**


1. Essentials Immunology – I. M. Roitt, 10th ed., Blackwell Scientific Publications, Oxford- 4th ed.
2. Kuby's Immunology – Murray, 5th ed.
3. Ivan M. Roitt, J. Brostoff and David K. Male, Immunology, Glower Medical Publishers, London.
4. Basic and Clinical Immunology, 5th ed. D.P.Sites, J.D.Stobo, H.H.Fudenberg and J.V.Wells Longe Medical Publications, Singapore.
5. Handbook of Experimental Immunology, Vol. I & II, IV-Blackwell Scientific publications.
6. Practical Immunology-Hudson L. and Hay H.C. Blackwell Scientific Publicartions.
7. Hybridoma Techniques: A Lab Course-Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India Ltd.

**Course: B.E. (Biotechnology)**
**Year: Semester VI**
**Subject: 6.4 Plant Cell and Tissue Culture**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit 1** [8 Hrs]
Introduction, media formulation, preparation of callus and cell cultures, shoot and embryo regeneration, micropropagation, acclimatization and establishment in the field.

2) **Unit II** [8 Hrs]
Haploids plants regeneration through anther and ambryo rescue, ovary culture, somatic hybridization, somaclonal variation.

3) **Unit III** [8 Hrs]
Automation in plant tissue culture, scaling-up of cultures including plant clones, somatic embryos, hairy roots and cell suspension.

4) **Unit IV** [8 Hrs]
Ti, Ri and virus vectors, methods of gene transfer.

5) **Unit V** [8 Hrs]
Transgenic plants: male sterility, virus resistance, insect resistance, keeping quality.

References:


1. Kruse P.E. & Patterson M.K. Tissue Culture Methods & Applications.
2. R.A. Dixon lant Tissue Culture, A Practical Approach – IRL Press
3. Vasil and Vasil- A series on Plant Tissue Culture.
4. Y. P. S. Bajaj – Plant Tissue Culture volumes

**Eight experiments out of the following experiments to be conducted:**

1. Preparation of nutrient media and its sterilization.
2. Multiplication of already developed plant and cell cultures
3. Introduction to different types nutrient media and their preparation along with suitable phytohormone requirements.
4. Explant preparations and their inoculation on suitable plant growth medium.
5. Callus induction in tobacco / any desired plant system.
6. Micropropagation / clonal propagation technique for plant multiplication
7. Regeneration of plants from callus culture.
8. Preparation of single cell suspension culture.
9. Induction of somatic embryogenesis
10. Introduction of crown gall / hairy root formation using Agrobacterium tumefaciens/ A. rhizogenes.
11. Isolation of protoplast.

# Course: B.E. (Biotechnology)
## Year: Semester VI
## Subject: 6.5 Bioreactor Analysis and Technology

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : --- |
| | TOTAL | : 100 marks |

**Syllabus:**

1) **Unit I** [8 hrs]
Modelling of bioreactors. Concept of ideal and non-ideal bioreactor, residehce time distribution.

2) **Unit II** [6 hrs]
Homogeneous and heterogeneous reactions.

3) **Unit III** [12 hrs]
Kinetic analysis of Bioreactors: Fludized bed, plug flow reactor, airlift, bubble column, continuous stirred tank reactor. Unconventional bioreactors: Hollow fibre reactor, membrane reactor, perfusion reactors.

4) **Unit IV** [6 hrs]
Practical aspects regarding design and operation of bioreactors.

5) **Unit V** [8 hrs]
Control of Bioreactor: Physical, chemical and biological environment of the bioreactor; PID controllers. Kilman filter, stranded Kilman filter, software sensor, fuzzy and neuro fuzzy controllers, biosensors.

**References:**


1. Bioprocess Engineering Principles- P.M. Doran, 5th ed.
2. Baily & oils- Biochemical Engineering
3. Chemical Reactor Engineering- Olvin spiel
4. Principles of Microbe and cell cultivation- S.Jhon Pirt
5. Chemical Engineering, Vol 5 & 6- Coulson & Richardson
6. Perr's Chemical Engineering Handbook, 7th ed., E.H. Perry & D.W. Green
7. Bioreactor Design & Product Yield: Biotol, Mijnbeek, Oosterhuis Siebel Oths, Butterworth Publications.

**Course: B.E. (Biotechnology)**
**Year: Semester VI**
**Subject: 6.6 Genetic Engineering and Technology**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 3 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** [10 hrs]
General characteristics of vectors used in genetic engineering, plasmid vectors viz. PBR 322, pUC plasmids, M13 vectors, lamda vectors, cosmids, phagemids, artificial chromosomes.

2) **Unit II** [8 hrs]
Expression vectors: promoter fusion and high level expression of cloned genes. Preparation of gene/ c DNA libraries, screening of the libraries.

3) **Unit III** [10 hrs]
Enzymes used in genetic engineering viz. Reverse tracriptase, Restriction enzyme DNA polymerase, polynucleotide kinase, terminal deoxynucleotidyl transferase, alkaline phosphatase, SI nuclease, Bal 31, DNA ligase etc; PCR, Nucleic acid synthesis, RFLP, RAPD, AFLP.

4) **Unit IV** [5 hrs]
Genetic transformation of E. coil and selection of recombinant clones. Induced expression.

5) **Unit V** [8 hrs]
Western, Southern and Northen blotting, dot-blot hybridization. Sequencing of DNA through Sanger's and Maxim and gilbert's method, automated DNA sequencing, Antisense technology.

References:


1. Albert's Molecular Biology of the cell- 4th ed. Garland Publication.
2. Benjamin Levin- Genes VIII, Oxford University Press.
3. Boyer-Molecular biology 2nd ed.,
4. Innis- Principles of Genetics, 8th ed.,
5. Old and Primrose Gene cloning
6. Robert Brown- Molecular Cloning- 3rd ed., 3vol.-
7. Samberbrook, Fritish Maniatis- Molecular Cloning. Vol. 1-3,
8. T.A. Brown Gene cloning, Chapman & Hall
9. T.K.Devlin- A Text Book of Biochemistry, 6th ed.,

**Course: B.E. (Biotechnology)**
**Year: Semester**
**Subject: 7.1 IPR, Bioethics and Biosafety**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | : 100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** [14 hrs]
Jurisprudential definition and conmcept of property, rights, duties and their correlation. History and evolution of IPR- likr patent, design and copy right, indian patent act 1970 (amendment 2000), international convention in IPR, major changes in Indian patent system as post TRIPS effects (I) obtaining patent (ii) geographical indiation.

2) **Unit II** [11 hrs]
Distinction among various forms of IPR, Requirment of a patentable novelty, invention step and prior art and state of art, procedure.

3) **Unit III** [11 hrs]
Rights/protection, infringement or violation, remedies against infringement - civil and criminal.

4) **Unit IV** [11 hrs]
Detailed information on patenting biological products, Biodiversity, Budapest treaty, Appropriate case studies.

5) **Unit V** [8 hrs]
Biosafety and Bioethics.

References:

1. Patent Strategy For Researches & Research Manegers- Knight, Wiley Publications.

**Course: B.E. (Biotechnology)**
**Year: Semester**
**Subject: 7.2 Environmental Biotechnology I**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | : 100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) Unit I [8 hrs]
Environmental pollution: water, air, and noise (introduction, sources and effects). Waste water: communal, sewage and industrial effluent: type of wastes, properties and steps involved in aerobic and anaerobic treatments.

2) Unit II [4 hrs]
Methanogenesis: methanogenic, acetogenic and fermentative bacteria-technique processes and conditions.

3) Unit III [10 hrs]
Principle and design aspects of various waste treatment methods, with advance bioreactor configuration: activated sludge process, trickling filter, fluidized expanded reactor, upflow anaerobic sludge blanket reactor, contact process, Fixed/packed reactor, hybrid reactors, sequential batch reactors.

4) Unit IV [8 hrs]
Kinetic models for biological waste treatment: Bioconcersions of agricultural and of highly organic waste material into gainfully utilizable products- biogas, $H_2$, cellular and food and feed stocks.

5) Unit V [10 hrs]
Process strategies for biomeditation through microbes and plants. Bioremeditation by industries, impact of regulatory policies on commercial development, prospects for process in the global bioremeditation industry, exploiting microbial metabolism bioremeditation of organic contaminants, heavy metals and nitrogenous wastes.

**References:**


1 J. Wimnter –Environmental Process I-III, 2nd ed., Wiley Publications
2. Metcalf & Fuddy –Waste Water Engineering-, 3rd ed., TMH publication
3. P.D. Sharma –Ecology & Envirinment-, 8th ed.
4. R.S. Ramalho – Introduction to Waste Water treatment-, Academic Press.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VII**
**Subject: 7.3 Bioseparation and Downstream Technology**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** [6 hrs]
Introduction; An overview of Bioseparation, Separation of cells and other insolubles from fermented broth.

2) **Unit II** [6 hrs]
Filtration and microfiltration. Centrifugation (batch, continuous). Designing of centrifuges for desired product of desired capacity.

3) **Unit III** [8 hrs]
Cell disruption: Physical methods- osmotic shock, grinding with abrasive solid shear, liquid shear. Chemical methods-alkali reagents, Enzymatic methods

4) **Unit IV** [10 hrs]
Product isolation: Extraction and adsorption method, solid-liquid separation, liquid-liquid separation, distillation, precipitation method using ammonium sulfate, organic solvents, high molecular weight polymers. Reverse osmosis.

5) **Unit V** [10 hrs]
Electrophoresis and chromatograph principles for product purification. Different electrophoresis techniques viz. Isoelectric focussing, chromatographic techniques viz. Paper, gel filtration, column, ion exchange, affinity, GLC, HPLC. Dialysis, ulterafilteratation. Product polishing: Crystallization and drying.

References:


1. Bailly & Ollis biochemical Engg., academic Press
2. H.Gunzler – Handbook of Analytical techniques- Wiley Publications.
3. H.J.Rehm and G.Reed, Biotechnology – Vol. 3,4,5, Verlag Publishers
4. Humphrey, Aiba & Miller, Biochemical Engg., academic Press
5. Murray Moo-Young Comprehensive biotechnology, Vol. II- latest ed., Pergan Publishers.
6. Product Recovery in Bioprocess Technology, Heinemann, Butterworth Publication.
7. Stanbury & Whitteker, Principles of Fermentation Technology, Pergamon Press
8. Westermeier – Electrophoresis in Practice, Wiley Publications.
9. Willared et al., -International Methods of Analysis- VBS Publication
10. Wilson and Golding, A Biologist's Guide to Principles & Techniques of Practical Biochemistry, Cambridge University Press.


**Eight experiments out of the following experiments to be conducted:**

1. Determination of air filter effeciency
2. Harvesting of fermentation broth and its processing for product purification.
3. Solid-liquid separation.
4. Liquid-Liquid separation
5. Disruption of Microbial cells.
6. Separation by precipation through adding salts and solvents.
7. Dialysis
8. Ultrafilteration
9. Vaccum Evaporation
10. Drying and crystallization.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VII**
**Subject: 7.5 (1) Biomedical Engineering**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** [10 Hrs]
Muscle structure and its attachment with selection, Rate of concentration and force generation, Activation contraction, Locomotion –stability, Forces on ground, Forces on muscles, Energy requirement, Mechanics of walling, Running and totting.

2) **Unit II** [6 Hrs]
Sports bio-mechanics, Mechanics of prosthetics and orthotics, Biomechanics of human injury and orthopedic fixation

3) **Unit III** [2 Hrs]
Mechanics of bone and joint, Dynamics of man machine interaction.

4) **Unit IV** [6 Hrs]
Electrical impedance cephalography, Biotelemetry, Biosignal analyzer, CT scan and Magnetic resonance imaging, Assisting the heart and kidney, ECG, EEB.

5) **Unit V** [6 Hrs]
Biosystem modelling, Ultrasound in diagnosis, limb prosthetics and orthotics, sensory acids for the blinds

References:


1. Buddy D. Ratner, Frederick, J. Schoen, Allan S. Hoffman, Jack E. Lemons.
2. David Cooney "Biomedical Engineering Principles: An Introduction to Fluid, heat and mass transport process" Stock ships.

Course: B.E. (Biotechnology)
Year: B.E. Semester VII
Subject: 7.5 (2) Non- Conventional Sources of Energy

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) Unit I: [4 Hrs]
Introduction to non-conventional sources of energy, importance of energy, advantages and disadvantages of non-conventional sources, sources and conversions of non-conventional energy sources to electrical energy.

2) Unit II: [8 Hrs]
Solar energy- introduction, solar constant determination, solar thermal decices, solar reflectors, absorbers and concentrators, photovoltaic cells and applications of solar energy.

3) Unit III: [8 Hrs]
Fuel cells. introduction, efficiency and thermodynamics of fuel cells, types of fuel cells, applications and future trends.

4) Unit IV: [8 Hrs]
Release of energy by fission and fussion reactions, theory and operation of fission reactors for power production (components of reactor), future fussion reactor and nuclear technology

5) Unit V: [8 Hrs]
Other sources of energ, geothermal energy, sources, utilixation and its importance and applications.

Wind and sea energy: Principle, utilization of wind and sea energy and its applications

**References:**


1. Tata Press: Non-conventional sources of Energy
2. Concepts in Science: A Publication of International Development Division, BITS, Pilani, India.
3. L. Allen et al., Energy and the Future, American Association for the Advancement of science.
4. J.C. Macveigh er al., An Introduction to the Applications of Solar Energy, Bergamon Press, 1977
5. Soo S L., Direct Energy Conversion, Prentice Hall (USA)

**Course: B.E. (Biotechnology)**
**Year: Semester VII**
**Subject: 7.5 (3) Protein Engineering**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** [11 Hrs]
Biosynthesis of proteins. Conformation studies of different proteins. Specific conformation of enzymes considering position of active sites.

2) **Unit II** [8 Hrs]
Effect of amino acids on structure of proteins. Energy status of a protein molecule, structure and function relation of enzymes.

3) **Unit III** [11 Hrs]
Physical methods such as X-ray crystallography for determination of protein structure. Site directed mutagenesis for specific protein function.

4) **Unit IV** [11 Hrs]
Basic concepts for designing a new protein/enzyme molecule.

5) **Unit V** [14 Hrs]
Specific examples of enzyme engineering, Tryesyl t RNA synthetase. Dihyrofolate reductase, Subtilisin.

References:


1. Klaus Dembowsky, Novel Therapeutic Proteins- Wiley Publications.
2. Messer-schmidt, Handbook of Metaloproteins- Wiley Publications.
3. Ronald Kellner et al., Microcharacterization of Proteins, 2nd ed., Wiley Publications.
4. Susane Brakmann, Directed Molecular Evolution of Proteins- Wiley Publications.
5. Walsh, Protein Biotechnology and Biochemistry, 2nd ed.,- Wiley Publications.
6. Westermeier-Proteomics in Practice- Wiley Publications.

**Course: B.E. (Biotechnology)**
**Year: Semester**
**Subject: 8.1 Transport Phenomena in Biotechnology**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

Syllabus:

1) **Unit I** **[10 Hrs]**
Molecular transport: Newton's law of viscosity, Fourie's law of Heat conduction, Fick's law of Diffusion.

2) **Unit II** **[10 Hrs]**
Transport in laminar flow: development of continuity (conservation) equations, velocity, temperature and concentration profiles, momentum, energy and mass flux.

3) **Unit III** **[10 Hrs]**
Equations of change for isothermal, non-isothermal and multicomponent systems. Navier- Strokes Equation. Eulr equation. Bernolulli Equation. Equation of energy.

4) **Unit IV** **[10 Hrs]**
Equation of motion for free and forced convection (heat/mass). Unified approach to physical rate processes associated with momentum, mass and energy transport.

5) **Unit V** **[10 Hrs]**
Differential and integral treatment on the conservation laws. Momentum, mass and energy transfer in laminar and turbulent flow with applications to interphase Microscopic balance.

References:


1. Bailly & Ollis, Biochemical Engg. – Academic Press.
2. Ghosal S.K., Sanyal, Dutta, Introduction to Chemical Engg.- TMH Publication.
3. H.Z.A. Akker – bioprocess Technology, Modelling & transport Phenomenon, Butterworth Publishers.
4. Introduction to Chemical Engg., Series, MCH International.
5. Winkelmann, Microbial transport Systems- Wiley Publications

**Course: B.E. (Biotechnology)**
**Year: Semester VIII**
**Subject: 8.2 Environmental Biotechnology II**

| | | |
|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : 3 Hrs. |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : 25 marks |
| | Oral Examinations | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** [10 Hrs.]

Factors of environmental degradation. Pollutants and their types: nature and source. Different biogeochemical cycles including nitrogen, carbon, hydrogen, oxygen etc. Pollution monitoring and measurement.

2) **Unit II** [10 Hrs.]

Sensors for environmental testing: Physical, Chemical and Biological for sensing the Pollutions.

3) **Unit III** [10 Hrs.]

Waste disposal and management; legislation of environomental problems, Microbiological and biochemical aspects of waste treatment process, microbial strain improvement with view to develop scavengers, bioremediation.

4) **Unit IV** [10 Hrs.]

Characteristics of wastewater; aerobic and anaerobic waste treatment process. Biological treatment of solid wastes, Process design, Single stage and two stage anaerobic digestion.

5) **Unit V** [10 Hrs.]

Down stream processing in biological treatment process: Effluent disposal and reuse. Biofilteration for waste gas treatment, purification of biogas, Containment of biological treatment process, Vermiculture technology, Wastewater treatment using aquatic plants, heavy metal removal by hairy roots.

References:


1. J.Winter, Environmental Processes I-III, 2nd ed., Wiley Publications
2. Metcalf- A book on waste water biotechnology
3. Ted Munn, Encyclopedia of Global Environmental Changes, 5 Vol. Set, Wiley Publications


**Following experiments are to be conducted:**

1. Physico-chemical and biological characterization of waste water.
2. Determination of total solids, total dissolved solids, total suspended solids, volatile solids, fixed solid/ash content and moisture content in solid waste and wastewater.
3. Determination of MLVSS.
4. Determination of sludge volume index and food to microorganisms.
5. Determination of Kjeldahl nitrogen, nitrate and nitrite nitrogen.
6. Determination of inorganic phosphates.
7. Determination of BOD of wastewater samples.
8. Determination of Cod of wastewater samples.
9. Enumeration of contaminating pathogenic organisms.

**Course: B.E. (Biotechnology)**
**Year: Semester VII**
**Subject: 83 Project Engineering**

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : --- |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : --- |
| | Term work | : 25 marks |
| | TOTAL | : 125 marks |

**Syllabus:**

1) **Introduction:** **(6 Hrs)**
Concept, definitions & terminology in projects, Project Engineering & Management. Project types, life cycles, phases. Project overruns, typical case studies.

2) **Project Initiation:** **(8 Hrs)**
Identification, various types of feasibility Reports, Project selection criteria, Technology selection criteria, Site selection criteria.
Process Development / Licensing, Basic Engineering and Detailed Engineering, Execution stages of work.
Guarantees, Liabilities & risk insurance.
Establishing Scope Time/ Costs/ targets for selected projects, Budgeting. (Project financing is excluded)

3) **Project Clearance** **(8 Hrs)**
Overview of various laws, regulations, rules that require clearances to be obtained. Intellectual property rights, patents & allied clearances. Need for such clearances and its influence on project, Engineering & Management.

4) **Human Resources for Project Execution** **(8 Hrs)**
Importance of human resources in success of a project. Intra - organisational team departments and their departments and their structures and interrelations. Role of conractors, subcontractors, Consultants. Selection and appointment & Co-ordination with Consultants/ Contractors.

5) **Project Execution** (8 Hrs)
Role of planning, Organizing, Scheduling in execution, PERT – CPM & other techniques of project Planning. Project work systems/ plans/ manual/ for intraorganisational projects. Work systems for Project Execution with contractors / subcontractors.
Material Management in project Execution.

6) **Project Monitoring & control** (8 Hrs)
Time & cost control tools & techniques. Control of contingency & changes. Importance of Contractors & venders performance in cost control. Fund Flow control.
Project Quality control – Importance of Environmental & safety aspects. Role of communications in monitoring & control.

7) **Project completion:** (8 Hrs)
Commissioning, Start up, stabilization & Closeout.

References:


1) Chaudhary, "Project Management", Tata McGraw Hill, New Delhi, Rs. 16500
2) Joy, P.K., "Total Project Management", The Indian Context, macMillan, 1993.
3) Modder JJ et. Al. "Project Engineering with CPM, PERT & Procedure Diagrams", Van Nostrand Reinhold, 1964.
4) Kharbanda, O.P., Staworthy E.A. "Project Cost Control in Action" Prentice Hall, 1981.
5) Kharbanda, O.P., Staworthy E.A. "How to learn from Project Disaster, Gpwer, 1987.
6) Kharbanda, O.P., Staworthy E.A. "Total Project Management from Concept to Completion" Gower 1983.
7) Cleland D.I., "Project Management – Strategy Design & Implementation, 2/e, McGraw Hill, 1994, $15
8) IDBI & ICICI guidelines for loan applictions.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VIII**
**Subject: 8.4 Process Plant Operations and Safety**

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

**Syllabus:**

1) **Introduction:**
Concept & definitions. Type of Accidents. Causes and direct & indirect effects of accidents, Types of damages
Role of saftey considerations in chemical plant Design & operations.
Protective and safety equipments.

Measure of Risk

Liabilities of accidents
Law, Rules, Regulations (concerning safety in chemical process plant) for the prevention of accidents. Managerial aspects of safety
General aspects of Post disaster mitigation and management within an organisation & in society at large.

2) **Toxicology and Industrial hygiene:**
Typical toxins and their biological effects. Outline of their ingestion to / elimination from biological system.
Toxicological Parameters- Their definitions and outline of the measurement methods.
Evaluation of Exposure to toxicants and its impact.
Source Models –Release & flow of toxic gases & liquids, flashing liquids, boiling liquids, etc.
Dispersion Models- factors affecting dispersion and their modelling. Design & Equipment for prevention of toxic release in chemical plants.
Management of toxic release scenario

3) **Fire & Explosions:**
The fire triangle and factors contributing to fire & explosions. Definition. Relevant material characteristics & properties.
Concepts of Ignition, ignition Energy. Phenomena and source of Ignition, auto ignition, auto oxidation, adiabatic compression, electrostatic ignition, role of fule sprays, mists dusts on ignition process.
Explosions – various types & conditions for their occurance.

4) **Prevention & Control of fire/ explosions:**
Inerting & Purging of equipment, Ventilation of rooms, Control of static electricity process control systems, Sprinkler systems, Fire fighting systems

5) **Relief & Relief systems:**
Definitions. Relief requiring scenarios. Relief types & locations. Relief systems, various options and their sizing and applications for single and multi phase flows
Deflagration venting for dust & vapor explosions.

6) **Hazard Identifications:**
HAZOP, HAZAN and such methods, safety Review & other method, examples. Safety Audit.

7) **Risk Assessment:**
Review of probability theory in respect of failures, coincidences etc. leading to unsafe situation.
Concepts of event trees & Fault trees. Analysis of trees. Analysis of trees for risk assessment its dvantages & disadvantages. Simple examples of application of Risk Assessment technique.

8) **Accident Investigations:**
Learning from accidents Methods of investigating and diagnosis aids for recommending
Case studies of well known accidents such as Flixborough Bhopal, Seveso etc.

**References:**


1. Crowl, D.A., Louvar , J.F. "Chemical Process Safety fundamentals with Applications" Prentice Hall, Englewood with 1990
2. Pandya, C.L., Hazard in Chemical Units "Oxford IBH 1994.
3. Pandya, C.L., Risk in Chemical Units: Oxford IBH 1994.
4. Grimaldi, J.V., Simsods, R.H., "Safety Management 5/e AITBS, Delhi, 1996

5. Kletz, T.A., "What went wrong ? "3/e, Gulf Publishing, 1995.
6. Lees, F.P., "Loss Prevention in Process Industries" Vol. 1,2 & #, Butterworth, 1995
7. Safety Related Acts, Rules & Regulations
8. Gupta, R.S., " Handbook of Fire Technology" Orient Longman, 1993.
9. Withers, J., "Major Industrial Hazard- Their Appraisal & Control, Wiley, New Delhi, 1988.
10. CLRI, "Hazard Assessment & Dissaster Mitigation in Chemical Process Industries" Oxford IBH, 1994.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VIII**
**Subject: 8.5 (1) Food Biotechnology**

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

**Syllabus:**

1) **Unit I** [8 Hrs]
Microbial role in food process, operation and production and production: new protein foods- SCP, mushroom, food yeasts, algal proteins.

2) **Unit II** [6 Hrs]
Fermentation as a method for preparing and preserving foods. Food additives like colouring, flavours and vitamins.

3) **Unit III** [8 Hrs]
Organisms and their use for production of fermented foods and beverages: pickling, alcoholic beverages, cheese, sour, Krat, idli, vinegar.

4) **Unit IV** [10 Hrs]
Deoxygenating and desugaring by glucose oxidase, beer mashing and chill proofing or cheese making by proteases and various other enzyme catalytic actions in food processing. Classification of fruit juice.

5) **Unit V** [8 Hrs]
Post harvest technology and process of food preservation.

**References:**


1. Frazier, Food Microbiology, THM Publications.
2. Heller, Genetic Engineering of Food: Detection of Genetic Modifications- Wiley Publications.
3. Lel A. et. Al., Microorganism & Fermentations- N.Y. Chemical
4. Rehm, Biotechnology Set Wiley Publications

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VIII**
**Subject: 8.5 (2) Metabolic Engineering**

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examinations | :100 marks (3 Hrs) |
| | Practical Examinations | : --- |
| | Oral Examinations | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I** **[6 Hrs]**
Basic concepts of metabolic engineering, Overview of cellular metabolism, Different models for cellular reactions.

2) **Unit II** **[10 Hrs]**
Metabolic regulation network at genome level and whole cell level, Example of metabolic pathway manipulations.

3) **Unit III** **[12 Hrs]**
Metabolic pathway synthesis algorithms, Metabolic flux analysis and its applications, Methods for experimental determination of metabolic fluxes by isotope labelling.

4) **Unit IV** **[10 Hrs]**
Analysis of metabolic control and structure of metabolic networks.

5) **Unit V** **[12 Hrs]**
Thermodynamics of cellular processes, New concepts for quantitative bioprocess research and development.

Rreferences:


1. M L Shuler, F Kargi "Bioprocess Engineering: Basic concepts" Prentice Hall PTR
2. Rehm, Reed & Weinheim, Biotechnology Series, Verlag-Chemie Publication

3. Athel Cornish- Bowden and Maria Luz Cardena "Technological and Medical Implications of metabolic control" Kluwer Academic Publishers.

4. Athel Cornish- Bowden and Maria Luz Cardenas "Control of Metabolic Processes" Plenum.

**Course: B.E. (Biotechnology)**
**Year: B.E. Semester VIII**
**Subject: 8.5 (3) Agricultural Biotechnology**

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|---|---|---|
| LOAD PER WEEK: | Lectures | : 4 Hrs. |
| | Practicals | : --- |
| | Tutorials | : 2 Hrs. |
| EVALUATION SYSTEM: | Theory Examination | :100 marks (3 Hrs) |
| | Practical Examination | : --- |
| | Oral Examination | : 25 marks |
| | Term work | : 25 marks |
| | TOTAL | : 150 marks |

Syllabus:

1) **Unit I:** **[10 Hrs]**
Genetics for plant breeding, study of plant genome, transgessive variation, quantitative and cytoplasmic inheritance

2) **Unit II:** **[10 Hrs]**
In vitro propogation of agronomically important crops, post pathogenic interactions, development of biopeptides

3) **Unit III:** **[10 Hrs]**
Plant improvement program, development of drought resistant, disease resistant and osmotically tolerant varaities, selection of better yeild and quality

4) **Unit IV:** **[10 Hrs]**
Plant genetic engineering, plant expression vectors and construction of transgenetic plants and their applications.

References:


1. Peter J. Russell, Genetics, Benjamin / cummings Publishing Co.
2. Agricultural Biotechnology,
3. Kruse B.E. and Patterson M.K., Tissue culture: Methods and applications.
4. Keshav Trehan, Biotechnology, wiley Easter Ltd.
5. Benjamin Lewin, Genes VIII
6. Innis, Principles of Genetics