B. Tech. Biotechnology Final Year (2003 Course)

TERM – I

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
416281	Elective – I	4	2		100			50	150
409343	Chemical Reaction Engineering II	4			100				100
416282	Enzyme and Fermentation Engineering	4	2		100		50	25	175
416283	Bio-Process Equipment Design	3		2	100		50	25	175
416284	Novel Separation Techniques	3	2		100		25	25	150
416285	Project			2					
		18	4	6	500		125	125	**750**

TERM – II

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	

416286	Elective – II	4			100				100
416287	Analytical Biotechnology	4	2		100	50		25	175
416288	Bioinformatics and regulations	4	2		100		50	25	175
409289	Plant Engineering	4		2	100			50	150
416290	Project			6			50	100	150
		16	6	8	400	50	100	200	**750**

List of elective subjects:

Elective – I

1. Environmental Biotechnology
2. Cosmetic Biotechnology
3. Pharmaceutical Biotechnology
4. Metabolic Engineering

Elective – II

1. Food Biotechnology
2. Biomaterials
3. Nano-Biotechnology
4. Bioethics and Biosafety

UNIVERSITY OF PUNE
B.Tech SEM (I)
416281: ELECTIVE I: ENVIRONMENTAL BIOTECHNOLOGY

Teaching Scheme: **Exam Scheme:**

Theory: 4 Hrs **Paper: 100 Marks**

Practical: 2Hrs/week **Term work: 50 Marks**

UNIT I: **[6Hrs]**

Introduction to waste water treatment, Characteristics of wastewater: Physical, chemical and biological characteristics, wastewater sampling and analysis, analyzing BOD and COD of waste waters, Wastewater treatment, necessity of treatment.

UNIT II: **[8Hrs]**

Biological processes: Activated sludge process, Biological principle, important microorganisms in waste water and their importance in waste water treatment systems, bacterial growth, general growth pattern, growth in terms of bacterial numbers and bacterial mass, kinetics of biological growth, cell growth, substrate limited growth.

UNIT III: **[6Hrs]**

Trickling filters and their biological principle, different T.F media and their characteristics, rotating biological contactors, aerated lagoons their principle, advantages and disadvantages, oxidation ditches their principle, advantages and disadvantages.

UNIT IV: **[6Hrs]**

Industrial waste waters: Introduction, neutralization, proportioning, sampling composite sample,, effluent sampling, their characteristics, different methods of treatment and

disposal of effluent and standards of the following industries: paper and pulp, sugar, textile, tannery, distillery.

UNIT V: **[8Hrs]**

Waste minimization*:* Introduction benefits of hazardous waste reduction and approaches to waste reduction, introduction to various treatment methods i.e; physical, chemical, biological treatment.

UNIT VI: **[8Hrs]**

Bioremediation: Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Practicals:

1. To study microbial flora of waste water
2. Determination of potability of water by MPN Test
3. Characterization of coliforms
4. To study quality of air
5. To study BOD
6. To study COD
7. Conductivity measurement of water
8. Effect of treatment method on coliform/ microbial content

Text books:

1. Waste water treatment and disposal – Metcalf 7 Eddy – TMH publications.

2. Environmental engineering – Peavy, Rowe – Mc Graw Hill Publications.

3. Wate water treatment – Rao and Dutta.

4. Waste water engineering – B.C.Punmia and Jain – Arihant Publications.

5. Environmental biology – Arora.

Reference books:

1. Waste water treatment for pollution control , Soli J. Arciwala, Tata Mc Graw Hill Publications.

2. Manual and sewage treatment – Public Health Department., Govt. of India.

3. Sewage disposal and treatment – Dr. Modi , Standard Publications, New Delhi.

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B. Tech. Biotechnology

(Final Year Sem I)

Elective I (416281): Pharmaceutical Biotechnology

Teaching scheme:	**Exam Scheme**
Theory: 4 hr/week	**Paper: 100 Marks**
Practical : 2 hr/week	**Term work: 50Marks**

Unit 1: Formulation of biotech products [8 hrs]

Introduction. Routes of drug administration, Types of dosage form. Manufacturing and evaluation of following dosages: Uncoated tablet, coated tablets, Modified-release drug dosage form – controlled and modified release dosage forms. Target oriented drug delivery system – colonic delivery, enteric-coated drug delivery, pulmonary delivery, liposomes. Skin patch. Parenterals. Emulsion. Suspension. Biotechnology-based pharmaceuticals.

Evaluation: Dissolution, disintegration, friability test, hardness test, Kinetic principles and stability testing – real-time and accelerated stability testing.

Unit 2: Pharmacokinetics of biotech drugs and biopharmaceutics [8 hrs]

Introduction, principles of first-order kinetics, first-order pharmacokinetics: Drug elimination following rapid i.v. injection. Pharmacokinetc analysis of urine data. Clearance rate as an expression of drug-elimination, Pharmacokinetics of drug eliminated by simultaneous metabolism and excretion. Kinetics of drug absorption – The method of residual (feathering curve), Wagner nelson method, the method of inspection. Bioavailability. Bioequivalence. Factors affecting drug elimination.

Unit 3: Pharmacology [8 hrs]

Pharmacology: Introduction. Drugs action: general principles - binding of drug molecules to cells, tachyphylaxis and desensitization, molecular aspects- targets for drug. Cellular mechanisms – excitation, contraction, secretion, cell proliferation and apoptosis. Biopharmaceuticals drugs from plants, prokaryote and eukaryote. Bioassay, animal models of disease and drug evaluation. ADME of drugs. Mechanism of following drug categories: NSAIDs, anti-infectives, anti- cancer, drugs acting on CNS and ANS.

Unit 4: Toxiocology [8 hrs]

Introduction, side effect, adverse effect, acute toxicity, chronic toxicity, toxicity testing, mutagenesis and carcinogenicity. Teratogenesis and drug-induced fetal damage. Allergic reaction to drugs. First-line of treatment, Antidotes.

Unit 5: Drug discovery and development [8 hrs]

Drug discovery pipeline. Hit and lead identification, sources of NCEs, Prototype drug, structure-activity relationship (SAR) and quantitative SAR (QSAR). In-silico drug discovery. Target-structure based drug discovery. Characterization and Bioanalytical aspects of recombinant proteins. The preclinical stages, clinical development, commercial aspect. NDE, IND. Individual variation and drug interaction including pharmacogenomics and proteomics.

Unit 6: Regulatory guidelines in pharmaceutical biotechnology [8 hrs]

ICH guidelines, United states Pharmacopoeia, Indian Pharmacopoeia, British Pharmacopoeia, European Pharmacopoeia. Definition: Drug, label, labeling, new drug, new animal drug, animal feed. Food, drug and cosmetic act. New drug application, Abbreviated NDA. FDA and its enforcement. Intellectual and Industrial property in pharmaceutical biotechnology. Case studies.

Practical:

1. Sterilization by autoclaving
2. Sterility testing of Dextrose injection I. P
3. Preparation of O/W or W/O emulsion
4. Preparation of suspension or manual filling of capsules
5. Dissolution, disintegration, friability test, hardness test, drug release: any one

6. Preparation of herbal extract
7. Transmucosal delivery
8. Study of anti-cancer activity
9. Visit to animal house/ Pharma industry: optional

Text book:

1. The Theory and Practice of Industrial Pharmacy. By Lachman L. CBS publication.
2. Essentials of Pharmacotherapeutics. By F.S. K. Barar. CBS Publication.
3. Pharmaceutical biotechnology. S. S. Korai. Vallabh Prakashn.

Referenc Books

1. Pharmacology. By Rang H. P. 5th edition. Elsevier publication.
2. Modern Pharmaceutics. By Banker G. S. 4th edition. Marcel Dekker Publication.
3. Indian Pharmacopoeia. Government of India
4. British Pharmacopoeia. British Government.
5. United States Pharmacopoeia. Government of USA.
6. Pharmaceutics. By Aulton
7. Pharmacokinetics. By Gibaldi M. Marcel Dekker Publication.
8. Pharmaceutical biotechnology: an introduction for pharmacists and pharmaceutical scientists. By Daan J. A. Crommelin. Taylor & Francis
9. *Pharmaceutical Biotechnology. Editor(s): Dr. Oliver Kayser, Prof. Dr. Rainer H. Müller*
10. *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes Into Drugs. By Rodney J. Y. Ho, Milo Gibaldi. Contributor Rodney J. Y. Ho, Milo Gibaldi.*

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B. Tech. Biotechnology (Final Year Sem I)

409343: CHEMICAL REACTION ENGINEERING - II

Teaching Scheme: **Exam Scheme:**

Theory: 4 hr/week **Paper: 100 Marks**

Unit I: Heterogeneous Reactions: **(8 Hrs.)**

Types, rates, contacting patterns. Fluid – Particle reactions: Selection of model Unreacted core model, progressive conversion model, Rate of reaction for shrinking spherical particles. Application to design. Fluidized bed with entrainment.
(6 Hrs.)

Unit II: Fluid – Fluid Reaction: **(8 Hrs.)**

Rate equation for reaction, kinetic regimes, slurry reaction kinetics, Aerobic fermentation. Application to Tower design, Mixer settler, Semi batch contacting pattern.

Unit III: Adsorption: **(8 Hrs.)**

Surface chemistry and adsorption. Isotherms, Determination of surface area by BET method. Catalysis: Determination of surface area, void volume and solid density, pore-volume distribution, catalyst selection, preparation of catalyst and its deactivation, poisoning and regeneration. Nature and mechanism of catalytic reactions

Unit IV: Diffusion in porous catalyst: **(8 Hrs.)**

Gaseous diffusion in single cylindrical pore. Diffusion in liquids in porous catalyst, surface diffusion. Mass transfer with reaction. Effectiveness factor, Experimental and calculated effectiveness factor, selectivity's for porous catalysts, rate and mechanism of deactivation

Unit V: Solid- catalyzed Reaction: **(8 Hrs.)**

Rate equation (For all resistances) experimental methods for finding rates, Determining controlling resistances and rate equation, product distribution.

Unit VI: Design: **(8 Hrs.)**

Introduction to design of Staged adiabatic reactors, fluidized bed reactor, slurry reactor, bubble, column reactor, fermentors (As multiphase reactors) Enzyme catalyzed reactions: Introduction to Michaelis –Menten kinetics, inhibition.

Text Book:

1. "Chemical Reaction Engineering", Levenspile Octave. ,John Wiley & Sons.

Reference Books

1. Chemical Engineering Kinetics: Smith J.

2.Chemical and Catalytic Reaction Engineering- Carberry & Verma.

3.Elements of Chemical Reaction Engineering: H. Scott Fogler.

4.Principles of Reaction Engineering: Dawande, Denett publications.

5.Heterogeneous Reactions: Analysis Examples and reactor Design. Vol.1 & 2- Doraiswamy L.K. and Sharma M.M.

6.An Introduction to Chemical Reaction Kinetics & Reactor Design.-C.G.Hill.

University of Pune

B. Tech. Biotechnology (Final Year, Sem I)

416282: Enzyme and Fermentation Engineering

Teaching Scheme:	**Exam Scheme:**
Theory:4 hr/week	**Paper:100 Marks**
Practical: 2 hr/week	**Oral: 50 Marks**
	Term Work: 25 Marks

Unit I **[10Hrs]**

Kinetics of Enzyme catalyzed reactions:

Introduction to simple enzyme kinetics with one and two substrate, other patterns of substrate concentration dependence, modulation and regulation of enzymatic activity, other influences on enzyme activity, enzyme deactivation, enzyme reactions in heterogeneous systems

Fermentation Process Kinetics:

Microbial Growth Kinetics: Monod Growth kinetics, Kinetic implications of endogenous and Maintenance metabolism, other forms of growth kinetics, other environmental effects on growth kinetics, introduction to product formation kinetics

Unit II **[8Hrs]**

Fermenter Design and operation – I

Types of fermentation: submerged fermentation, solid state fermentation, advantages and disadvantages, types of submerged fermenter and solid state fermenters, Modes of operation in stirred reactors: discontinuous batch operation, continuous operation, open and closed loops controlled reactors, semi-continuous reactors, and periodic fed-batch cultivation, Bubble Column, Air lift, tray bioreactors, packed bed, hollow fiber Configuration and application.

Unit III **[8Hrs]**

Fermenter Design and operation – II

Detailed study of design and operation of different types of fermenters, ancillary fittings like sampling port, impeller design ,agitator power requirements, measurement and control of dissolved O_2,CO_2, temperature, pH and foam. Effect of rheological properties and its importance in fermentation operation.

Aeration and Agitation, effect of shear, O_2 requirement of microorganisms, mass transfer theory, diffusional resistance to oxygen transfer, measurement of mass transfer coefficient and factors affecting them. Effect of Aeration and Agitation on mass transfer

Unit IV **[8Hrs]**

Scale Up of Fermentation Process:

Principles, theoretical considerations & techniques used. Fermentation media, HTST sterilization-advantages and disadvantages, liquid sterilization techniques, Heat balance across a batch sterilization process, thermal death kinetics

Unit V **[8Hrs]**

Immobilized Enzyme Technology:

Enzyme Immobilization, Industrial Processes, Medical and analytical application of immobilized Enzymes, utilization and regeneration of cofactors.

Immobilized Enzyme Kinetics: Effects of external Mass transfer Resistance, analysis of intraparticle diffusion and reaction.

Unit VI **[8Hrs]**

Advanced Fermentation Techniques:

Microfermenters for Rapid screening and analysis of Biochemical processes, Animal & Plant Cell Reactor Technology, Semi synthetic Fermentation Processes:- case study-Penicillin Production, Disposable Fermenters :- case study- Therapeutic Antibody Production,

Practical:

1. Isolation and screening of industrially important microorganisms.
2. Preparation, calibration, and standardization of a reactor.
3. Power calculations,KLa determination of a typical bioprocess
4. Study of kinetics of cell growth
5. Study of kinetics of product formation
6. Fermentation of alcohol and wine production
7. Fermentation of vitamins and antibiotics
8. Use of alginate for cell immobilization.
9. Calculation of Fermentation efficiency.
10. Study of solid state Fermentation

Text Books:

1. Biochemical Engineering Fundamentals by Bailey and Ollis (McGraw Hill,

New York.)

2. Bioprocess Engineering Principles by Paulin M.Doran (Academic Press,

London)

3. Principles of Fermentation Technology (1997),Stanebury P.F, and Whitaker

Reference Books:

1 .Biochemical Engineering by R. Steel (Chemical Publishing Co.Inc.,New

2. Biochemical Engineering by Aiba S., Humphrey. A.E and Milli N.F

(Academic Press, NY)

3. Industrial Microbiology (1992)4th edition, Prescott & Dunn

4. Fermentation and biochemical engineering handbook: Henry C Vogel.

5. Enzyme assays – a practical approach: Robert Eisenthal and Michael J Danson.

University of Pune

B. Tech. Biotechnology (Final Year, Sem I)

416283: Bio-Process Equipment Design

Teaching scheme: **Exam Scheme**

Theory: 3 hr/week **Paper: 100 Marks**

Drawing: 2 hr/week **Oral: 50Marks**

Term Work: 25 Marks

Unit: I Process Systems *(8 Hrs.)*

Design of Filtration equipments:

Study of various types of filters like vacuum filters, Pressure filters, centrifuges and rotary drum filters, Design of rotary drum filters including design of drum, shaft, baring and drive system.

Tangential flow filtration systems for clarification and concentration:

Introduction, TFF in Biotechnology, TFF system design, TFF operation and its relationship to design

Chromatography systems:

Introduction, engineering aspects of scale up, equipment, automated chromatography systems, Installation, commissioning and validation

Unit II: System Component *[10 Hrs]*

Vessels of Biotechnology:

Design and Materials: Introduction, relevant guidelines and customer specifications, vessel material, surface treatment, design considerations, components of the biotechnological vessel

Piping and valves for Biotechnology

Design, piping materials, polishing, passivation, sizing of pipes and tubes, connections and cleanability, In-line instruments, piping applications, hoses, valves.

Cartridge filtrations for biotechnology:

Introduction, types of filters, filter applications-fermentation and cell culture, downstream processing, utilities, steam sterilization procedures, filter integrity testing, validation of filters used in biotechnology manufacturing

Unit: III: Pressure Vessels: ` *(8 Hrs)*

Proportioning of pressure vessels, selection of L/D ratio, optimum proportions of vessels. Design of unfired pressure vessels: Types of pressure vessels, material of construction, selection of corrosion allowance and weld joint efficiency, purging of vessels.

*Design of high pressure vessels****: Materials of construction, review of design of thick cylinder, pre-stressing, Analysis and design of high pressure vessels: monoblock and compound (multilayer)***

Unit: IV Heat Exchangers: (8 Hrs)

Introduction, types of heat exchangers, codes and standards for heat exchangers, materials of construction, baffles and tie rods, tube joining methods, Design of shell and tube heat exchangers (U tube and fixed tube) as per IS: 4503 and TEMA standards

Design of heat exchange equipments such as evaporator, plate type heat exchanger, bayonet heat exchanger

Unit: V Agitators and Reaction vessels:
(8 Hrs.)

Study of various types of agitators, their selection , applications , baffling , power systems which includes twisting moment , equivalent bending moment, design of blades Reaction vessels- Introduction ,classification , heating systems , design of vessels, study and design of various types of jackets like plain, half coil, channel, limpet oil. Study and design of internal coil reaction vessels, Heat transfer coefficients in coils

Unit VI: Design of distillation column *(8 Hrs.)*

Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing , plate contactors, plate hydraulic design.

Term Work

Drawing of any **Six** equipments from unit 1 to 4 & Unit 6.

Text Books:

1."Process Equipment Design" by M.V. Joshi, McMillan India.
2. "Bioprocess Engineering-Systems, Equipment and Facilities" Edited by Bjorn K. Lydersen, Nancy A D'elia and Kim L. Nelson. A Wiley Interscience Publication.
3. "Introduction to Chemical Equipment Design" by B.C. Bhattacharya C.B.S. Publications.

Reference Books

1. "Process equipment design" by L.E. Brownell and E. Young, John Wiley, New York, 1963.
2. "Chemical Engineering Vol. 6" by J.M. Coulson, J.F. Richardson, and R.K. Sinott, Pergamon Press.
3. "Chemical Engineering volume 2" by J.M. Coulson, J.F. Richardson, and R.K. Sinott Pergamon Press.
4. "Mixing theories and practices" by Uhl V.W. and Grey J.B. Academic Press, New York, 1967.
5. "Mass Transfer Operations" by Treyball R.E., McGraw Hill, New York.
6. "Chemical Process Equipment-Selection and design" Walas S.M. , Butter worth Heinamer, McGraw Hill book company, New York.
7. "Indian standards Institution" code for shell and tube heat exchangers, IS – 4503
8 "Applied Process Design for Chemical and Petrochemical Plants" vol 1 and 2, Ludwig E.E., Gulf publishing co. publishing company, Texas.

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B. Tech. Biotechnology Final Year (Sem I)

(416284): Novel Separation Techniques

Teaching Scheme: **Exam Scheme:**

Theory: 3 hr/week **Paper: 100 Marks**

Practical: 2hr/week **Oral: 25 Marks**

Term Work: 25 Marks

UNIT I: **[6Hrs.]**

Role of downstream processing in biotechnology

An overview of bioseparations, bioprocesses, range and characteristics of bio products, need for downstream processes, characteristics of fermentation broths, an overview of bioseparations, case studies.

UNIT II: **[8 Hrs]**

Chromatography and Ion exchange

Introduction to Ion exchange, anion exchange, cation exchange, resins, action of ion exchange resins, ion exchange chromatography, applications, introduction to column chromatography, types of liquid chromatography, equipment for HPLC, applications, Introduction to gas chromatography, apparatus, quantitative analysis of GLC, elemental analysis using GC, applications, gel filtrations, size exclusion chromatography, basic principles, materials for gel filtration, equipment for gel filtration, equipment, applications.

UNIT III: **[8 Hrs]**

Membrane Processes

Classification of separation techniques, Membrane separations, Definition of a membrane, Criteria of membrane separation processes, Types of membranes, Advantages of membrane separation processes over conventional separation techniques, Industrial Applications, Micro filtration, Ultra filtration, Reverse Osmosis, Piezodialysis, Electro dialysis, Pervaporation, Carrier mediated transport- liquid membranes, Membrane contactors, and industrial applications of all processes.

UNIT IV: **[6 Hrs]**

Spectroscopy

Introduction to spectroscopy, spectroflourometry, instruments for flourometric analysis, applications, introduction to atomic emission spectrometry, equipment, qualitative spectrographic analysis, quantitative spectrographic analysis, spectroscopy, Introduction to NMR.

UNIT V: **[6 Hrs]**

Adsorption

Introduction, Principle, Adsorption isotherm models, - Langmuir isotherm and Freundlich isotherm, Differential and Integral heat of adsorption, Gibbs adsorption isotherm. Industrial applications, Classification, Physical adsorption, Chemical adsorption, Temperature swing adsorption, Pressure swings adsorption, Applications, Pore diffusion model (Zeolites).

UNIT VI: **[6 Hrs]**

Zone refining, Molecular sieves, Adductive crystallization, Supercritical fluid extraction, Reactive distillation, Reactive extraction, Thermal diffusion, Isothermal chromatography, Introduction to SEP box and Hyphenated techniques.

Practicals:

Any eight practicals are to be performed and two study experiments should be given.

1. Gas chromatography – Mixture of solvents and solutions.
2. Column chromatography – Organic – Separation of a mixture of ortho and paranitroaniline
3. Column chromatography - Inorganic – Separation of metal ions from a mixture.
4. Thin layer chromatography – Find out the R_f (Retardation factor) of the given amino acid mixture by Thin Layer Chromatography.
5. Separation of casein protein from milk.
6. Investigate the adsorption of Oxalic acid by activated charcoal and test the validity of Freundlich isotherm – time varied experiments.
7. Spectrophotometry - Verification of Beer Lambert's law by calculating λ_{max} and
8. determination of concentration of unknown solutions.
9. Demonstration of Infrared spectroscopy.
10. Demonstration on SEP BOX.
11. Size exclusion chromatography.
12. Hydrophobic interaction chromatography.
13. HPLC

Text books:

1. Mass Transfer Operations, Robert E. Treybal, Third edition, Mc Graw hill International editions.
2. Coulson and Richardson's Chemical engineering, J.F.Richrdson and J.H. Harker with J.R.Backhurst, Fifth edition, Volume II.
3. Vogel's Textbook of Quantitative Chemical Analysis, 6^{th} edition, J.Mendham.
4. Vogel's Textbook of Quantitative Chemical Analysis, 5^{th} edition, G.H.Jeffery.
5. Bioseparations, principles and techniques, B.Sivashankar.

University of Pune

B. Tech. Biotechnology

(Final Year) Sem II

Elective II (416286): Food Biotechnology

Teaching Scheme: **Exam Scheme:**

Theory:4 hr/week **Paper:100 Marks**

UNIT I

Introduction to Food Biotechnology [6]

Biotechnology in relation to the food industry, Food processing, General engineering aspects and processing methods. Preliminary processing methods, conversion and preservation operations. nutritional value of food, spoilage of food, Microorganisms in water, milk, vegetables, fresh meats and poultry, processed meats, seafood's, fermented dairy products and miscellaneous food products.

UNIT II **[10]**

Introduction to Physical and chemicals methods of food preservation: Principles and methods of food preservation- Refrigeration, Freezing, heating, dehydration, drying, canning, extrusion cooking, hydrostatic pressure cooking, dielectric heating, microwave processing, aseptic processing, juices and concentrates, membrane technology, additives, irradiation. Storage of food, modified atmosphere packaging.

UNIT III **[9]**

Technologies used for microbial production of food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology of food flavor production, microbial production of oils and fats, food applications of algae, butanol production from agricultural biomass.

UNIT IV **[9]**

Fermentation biotechnology of traditional foods of the Indian subcontinent, Fermentative production of food, Pickling and alcoholic beverages, Process developments in solid state fermentation for food applications, solid state bio-processing for functional food ingredients, Single cell protein, new protein foods, fermentation of milk and fermented milk products, cream butter, cheese, yogurt, ghee.

UNIT V **[8]**

Role of Enzymes in Food Processing: Starch and sugar conversion processes or baking by amylases; de-oxygenation and desugaring by glucose oxidase; beer mashing and chill-proofing or cheese making by proteases and various other enzyme catalytic actions in food processing. Enzyme in bakery and cereal products, production of pectinases and utilization in food processing

UNIT VI **[8]**

Anaerobic processes for the treatment of food processing waste

Classification and characterization of food industrial waste from fruit and vegetable processing industry; fish meat and poultry industry, sugar industry, dairy industry; Waste disposal methods-physical, chemical and biological; Treatment methods for liquid wastes from food industry; Treatment methods of solid wastes, economical aspects of waste treatment and disposal

Text Book

1. Food Biotechnology (Second EditionI– Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E Levin, Taylor and Francis
2. Frazier, Food Microbiology,
3. Fellows P. , Ellis H., 1990 – Food Processing Technology Principles and Practice –New York

Reference book

1. Introduction to Food Biotechnology, by Johnson-Green, Perry
2. Roger A., Gordan B., and John T., Food Biotechnology, 1989.
3. George J.B., Basic Food Microbiology, CBS Publishers Distributors, 1987.

4. James M .J. Modern Food Microbiology, CBS Publishers & Distributors, 1987.
5. Lindsay, Willis Biotechnology, Challenges for the flavor and food Industries, Elsevier Applied Science, 1988.
6. Desrosier, Technology of food preservation, CBS Publishers
7. Jay, Modern Food Microbiology, CBS Publishers, 1987
8. G. Reed, Prescott and Dunn's Microbiology, CBS Publishers, 1987

University of Pune

B. Tech. Biotechnology

Final Year (Semester II)

Elective II - 416286: Biomaterials

Teaching scheme: **Exam Scheme**

Theory: 4 hr/week **Paper: 100Marks**

UNIT I **[9 Hrs]**

General properties of Materials. Classes of materials used in medicine: Metals, Polymers, Hydrogels Bioresorbable and Biodegradable Materials, Ceramics, Natural materials composites thin films, grafts, Coatings medical fibers and Biological functional materials, Smart materials, Pyrolytic Carbon for long-term medical Implants textured and Porous materials non-fouling surfaces

UNIT II **[9 Hrs]**

Biopolymers: Classification (nucleic acid, protein, polysaccharide). Manufacturing, chemistry and applications of polysacchaaride such as dextran,xanthan,gellan,pullalane, chitin, chitosan, etc. structural characterization using protein sequencing by Edman degradation, mass spectrometer, optical tweezer (or atomic force microscopy).

UNIT III **[9 Hrs]**

Fermentative production of polyesters with special emphasis on polyhydroxyalkanoates, and biodegradable polymers such as polylactic acid, polyglycolide and polycaprolactone, lactoyllactic acid. Structure, physical and chemical properties including production of the above polymers.

UNIT IV **[9 Hrs]**

Application of biocatalyst such as enzymes and microorganisms in biotransformation process, development of polymer precursors using Biotransformation processes. Precursors: aromatic hydrocarbons, biological formation of specialty hydroxylated monomers, L-homophenylalanine production using membrane bioreactor.

UNIT V **[9 Hrs]**

Types of bioadhesive, nano biomaterial, composite biomaterial. Evaluation of biocompatibility according to United States Pharmacopoeia. Biodegradable plastic. design, synthesis, characterization and application of nanomaterials to biological and biomedical problems. Characterize, predict, and control the biological properties of nanobiomaterials.

UNIT VI **[9 Hrs]**

Applications of materials in medicine, Dentistry and Biology: Cardiovascular medical devices. Nonthrombogenic treatments and Strategies. Dental implantation adhesive and Sealants. Ophthalmologic applications-intraocular lens implants. Orthopedic biomaterials, Artificial organs and tissues.

TEXT BOOKS:

1. Biomaterials Science: An Introduction to Materials in Medicine Buddy D. Ratner, Frederick J. Schoen, Allan S. Hoffman, Jack E. Lemons
2. Hench L L Ethridgc E.C. Biomaterials, an interfacial approach, Academic press 1982

REFERENCE:

1. Bronzino J D, The biomedical engineering handbook CRC Press

University of Pune

B.Tech. Biotechnology

(Final year) Sem II

416287: Analytical Biotechnology

Teaching scheme:	**Exam Scheme**
Theory: 4 hr/week	**Paper:100 Marks**
Practical:2 hr/week	**Practical:50Marks**
	Term Work: 25 Marks

Unit I

Techniques in recombinant DNA technology

Techniques in rDNA technology, Southern Blotting, PCR-design and optimization, RTPCR, automated DNA sequencing method, sequencing strategies and analysis and applications, , microarrays, flow cytometry , gene sequencing

Unit II

Tools in genetic engineering

Enzymes used in GE, DNA modifying enzymes, restriction enzymes, modifying enzymes, DNA ligase, polymerase for GE,

Unit III

Cloning vectors

Plasmids, Multiple cloning sites, selection markers, lambda phage, phgemids, cosmids, artificial chromosomes (BACs, YACs), shuttle vectors, virus based vectors

Unit IV

Gene libraries

Cloning strategies: DNA cloning, cDNA synthesis, genomic DNA libraries, cDNA librariy, amplification of gene libraries, identifying the products of cDNA clones, isolation, selection of recombinants, screening libraries, sequencing, and synthesis of gene, different methods of gene isolation, techniques of DNA sequencing, artificial DNA synthesis, screening of recombinant clones, PCR cloning

Unit V

Gene transfer technologies, transformation, transfection, translocation, conjugation.

Unit VI

Applications of rDNA technology in health and agriculture: Humulin, Hep B, factorVIII,

DNA markers for improvement of quality and yield of crops. RFLP, RAPD, AFLP, Gene therapy

Practicals

1. Isolation of template DNA
2. Isolation of vector DNA
3. RE digestion of vector and template
4. Ligation with plasmid DNA
5. Transformation
6. Selection of recombinants blue white
7. Conformation of insert
8. PCR
9. Real time PCR (demo)

Text Book:

Principles of Gene cloning by Old and primrose

Reference Books:

1. From Genes to clones by Winnacker. PANIMA
2. Molecular biotechnology by Pasternack and Glick
3. From genes to genomes:concepts and applications of DNA technology by J. W. Dale and M.V.Schartz
4. Gene cloning and DNA Analysis: An introduction (4^{th} edition) by T. A. Brown
5. Molecular cloning by Sambrook, et al

University of Pune

B. Tech. Biotechnology

Final Year (Sem II)

Term II (416288) - Bioinformatics and Regulations

Teaching Scheme:	**Exam Scheme:**
Theory: 4 hrs/week	**Paper: 100 Marks**
Programming: 2 hrs/week	**Oral: 50Marks**
	Term Work: 25 Marks

Unit 1 **(8 Hrs.)**

Overview bioinformatics applications, Major databases, Techniques in Genetic Engineering & their applications in data generation. Introduction, working with FASTA, working with BLAST, filtering and capped BLAST, FASTA, & BLAST algorithms & comparison. Clustal analysis, Clustering and classification. Algorithms in bioinformatics

Unit2 **(8 Hrs)**

Protein structure, protein chip, Protein databases, secondary databases, structural databases, various analytical tools

Unit3 **(8 Hrs)**

DNA sequencing, Nucleic acid, Nucleotide databases, analytical tools such as multiple sequence alignment. Statistics of alignment. Comparative genomics. Gene expression analysis, Microarray analysis & their applications.

Unit 4 **(8 Hrs)**

C Programming. New vaccine designs, Epitope analysis. Future scope of bioinformatics in biotechnology product development, Profile of companies engaged in Bioinformatics tools package development

Unit 5 **(8 Hrs.)**

Regulatory requirements for Biotech. product development, Heicherical structure in Indian biotechnology. Current GMP, Role of DCGI, National& International guidelines.

Unit 6 **(8 Hrs)**

Quality Assurance, Quality control requirement for Biotech product. Toxicity, clinical trials, studies, clinical research & clinical data management, IPR patents, trademarks, trade secrets, Export, Import of product, Rules & Regulations for start up companies.

Practicals:

1. **Database searches:** Search and retrieval of sequence and structure data from biological databases using query engines such as Entrez and SRS
2. **Programming exercises for Sequence data analysis**: such as development of codes to:
    a. read sequences of genes/proteins given in specific formats,
    b. compute nucleotide or amino acid compositions (of gene/protein sequences),
    c. compute frequencies of monomers, dimers, trimers etc.,
    d. pattern matching to identify exact or fuzzy sequence patterns
3. **Structure Visualization and Analysis**: Use of different visualization software (e.g. RasMol, SwissPDBViewer) to visualize protein structures and understand secondary structural motifs, tertiary structures etc.
4. **BLAST and FASTA**: Use of different versions of BLAST and FASTA programs, interpretation of results to identify homologues of genes/proteins from databases
5. **Pair-wise Sequence Alignments** and their interpretation/analysis: sequence alignments using implementations of Needleman-Wunsch and Smith-Waterman algorithms
6. **Multiple Sequence Alignments** using CLUSTAL-W method with analysis of the alignments to find conserved, variable regions.
7. **Sequence and Structure Classification**: Search and retrieval of data from sequence and structure classification data bases with analysis of search results (e.g. PFAM, SCOP databases)
8. **Epitope Prediction:** Use of various epitope prediction methods; interpretation and analysis of the prediction results to identify potential candidates for vaccine design.

Text Books

1.S.C.Rastogi,N.Mendiratta,P.Rastogi., “Bioinformatics –Methods & Applications,

[RMR]PHI

2.Bryan Bergeron, “ Bioinformatics computing”, Pearson Education[BB]

Reference Books

1.Imtiyaz Alam Khan (IAK, " Elementary Bioinformatics", Pharma Book Syndicate

2.INdu Shekhar Thakur (IST), "Enviromental Biotechnology",IK International Publication

3.Recombinant DNA guidelines, DBT, GOI

4. GOI gadgets.

University of Pune

B. Tech Biotechnology Final Year (semester-II)

409289: Plant Engineering

Teaching Scheme:	**Exam Scheme:**
Theory: 4 hrs/week	**Paper: 100 Marks**
Drawing: 2 hrs/week	**Term Work: 50Marks**

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*Unit I: Introduction**:*** *(8 Hrs.)*

Basic considerations in chemical plant design, Preliminary design, design estimates. Process design aspects, Process flow Diagrams and symbols: Symbols of Process Equipments & their concepts, engineering line diagram (flow diagram). Utility block diagram, Process flow diagram, P & ID presentations relevant to chemical engineering processes. Pilot Plant: Importance of laboratory development to pilot plant, scale up methods .

Unit II: Detailed process design: *(8 Hrs.)*

Basic engineering in process, thermodynamic and kinetic feasibility, process feasibility, capacity identification, and selection process specification equipment specification material selection role of design office and technical data management, process design plant engineering plant safety operation and maintenance Plant location and layout: Factors affecting site selection, factors affecting both planning and layouts, drawing of process flow diagram.

*Unit III: Process Utilities**:*** *(8 Hrs.)*

Selection considering process conditions, capacity estimation and economic factors for various utilities like Process water, boiler feed water, chilling plant, compressed air and vacuum, refrigeration and brines. Water treatment, waste treatment and disposal heating system.

*Unit IV:Piping Design & Layout**:*** *(8 Hrs.)*

Hydraulic design consisting pipe size estimation estimation. Pressure loss determination thrust in pipeline water hammer design of gas pipelines transportation of solids in pipeline pipe support, Pipe routing,expansion and contraction of piping and its compensation thermal insulation of piping heating and cooling, colour code of pipeline, bill of material of piping, piping system design for process involving steam, cold and hot process fluids natural gas.

Unit V: Transportation equipments: *(8 Hrs.)*

Specification and selection of pumps performance chacteristics NPSH calculations pumping system design types of compressors fans blowers and vacuum systems operation and maintenance of plant and auxiliary systems (routine and preventive maintenance)

*Unit VI: Project scheduling techniques**:*** *(8 Hrs.)*

CPM/PERT techniques .project engineering project planning plant errectioning and testing commission sing ,HAZOP risk analysis industrial safety introduction to statutory regulations petroleum rules Indian boiler regulations (IBR`) static and mobile pressure vessels (SVPV).Factories act environment, energy law.

Drawing:

1.Minimum six drawing of following preferably on Auto CAD.

- ***Process flow diagram.***
- ***Piping and instrumentation diagram.***
- ***Plant layouts and elevations.***
- ***Piping GA drawing.***

2. Minimum two assignments based on theory to be solved on computer.

Text Books:

1. Plant design and Economics for chemical engineers, peter M. S. Timmerhaus, K. D. McGraw Hill.
2. Project Engineering with CPM and PERT, Modes J. Philips, Rheinhold publishers.

Reference Books:

3. Systematic design of chemical process plants, Grossman, Biegler and Vesterberg.
4. Turton et al, "Analysis synthesis and design of chemical processes, Prentice-Hall.