NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

SYLLABUS OF

FINAL YEAR ENGINEERING (B.E.)

BIOTECHNOLOGY

TERM – I and II

W.E.F. 2009-2010

NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING and EVALUATION

B.E. (BIOTECHNOLOGY) W.E.F.2009-2010

First Term

Sr. No.	Subject	Teaching Scheme Hours/Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Bioprocess Engineering - I	04	--	03	100	25	--	--
2	Bioprocess Modeling and Simulation	04	04	03	100	25	25	--
3	Bioseparation Processes	04	--	03	100	25	--	--
4	Elective –I	04	--	03	100	--	--	--
5	Fermentation Biotechnology-II	04	04	03	100	25	--	50
6	Project –I	--	02	--	--	25	--	25
7	Seminar	--	02	--	--	25	--	--
		20	12		500	150	25	75
	Grand Total	32			750			

Second Term

Sr. No.	Subject	Teaching Scheme Hours/Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Bioprocess Engineering -II	04	04	03	100	25	--	25
2	Bioprocess Engineering and Economics	04	02	03	100	25	--	25
3	Bioinformatics	04	04	03	100	25	25	--
4	Elective –II	04	--	03	100	25	--	--
5	Project –II	--	04	--	--	100	--	50
6	Industrial Visit / Case Study	--	--	--	--	25	--	--
		16	14		400	225	25	100
	Grand Total	30			750			

Elective – I

1. Advanced Biomaterials.
2. Plant Tissue Culture and Plant Biotechnology.
3. Protein Engineering.
4. Food Biotechnology.

Elective – II

1. Metabolic Engineering.
2. Biosafety and Bioethics.
3. Biomedical Fluid Dynamics.
4. Applied Genetic Engineering

B.E.BIOTECH. TERM-I

1. BIOPROCESS ENGINEERING-I

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit: I

Design of bioreactors and scale up:

Introduction, Basic objective in design of a reactor, aseptic operation and containment, body construction, aeration and agitation, stirrer glands and bearings, baffles design, sparger system, achievement and maintenance of aseptic conditions, valves and steam traps, types of valves and pressure control valves.

Scale up of fermenters, design condition for scale up, scale-up methods.

(10 Hrs, 20 Marks)

Unit II

Bioreactors

Types of bioreactors: Batch bioreactors, Continuous bioreactors, Semicontinuous bioreactors, Stirred tank bioreactors, Airlift bioreactor systems, Trickle bed bioreactor, Airlift external loop bioreactors, waldhof-type fermenter, Tower fermenter, Cylindro-conical vessel, Deep jet fermenters, Cyclone column, Rotating disc fermenters, Reactor dynamics: Dynamic models and stability.

Solid state fermenter: Introductions, types of solid state fermenter, few examples of bioproducts produced from solid state fermenter.

(10 Hrs, 20 Marks)

Unit III

Bioreactors configuration:

Enzyme reactors, batch growth of microorganisms, continuous culture of microorganisms, stirred tank reactor with recycle of biomass, continuous stirred tank fermenters in series, Fed batch fermenters, plug flow fermenters, problems on above, estimation of kinetic parameters (batch and continuous culture experiments).

(10 Hrs, 20 Marks)

Unit IV

Bioreactor Design Considerations:

Design consideration: Design codes, maximum working pressure, design pressure, design temperature, design stress, factor of safety, and selection of factors of safety, design of wall thickness, corrosion ratio, Poisson ratio, criteria of failure.

Materials of construction: mechanical properties, materials, corrosion, protective coating, choice of materials, corrosion prevention.

Brief introduction to pipe joints. (10 Hrs, 20 Marks)

Unit-V

Process design of bioreaction vessel: Introduction, materials of construction, agitation, classification of bioreaction vessels, heating systems, design of bioreaction vessels.

Agitators: Introduction, types of agitators, baffling, power requirements, design of turbine agitator.

(10 Hrs, 20 Marks)

REFERENCES:

1. Cooney and Humphery, Comprehensive Biotechnology, Volume-2, Elsevier Publication.
2. Syed Tanveer Ahmad Inamdar, Biochemical Engineering Principles and Concepts, , PHI Publication.
3. James E. Bailey, David F. Ollis, Biochemical Engineering Fundamentals, Mcgraw –Hill, International Edition.
4. Paulin.M.Doran, Bioprocess Engineering Principles, Elsevier Publication.
5. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering - Basic Concepts, PHI Publishers.
6. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Aditya books, Private Limited New Delhi.
7. B.D Singh, Biotechnology- Expanding Horizons, Kalyani Publications.
8. Operational Mode of Bioreactors- Biotol series ,Elsevier Publications.
9. B.C.Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS publisher and Distributors, New Delhi.
10. M.V.Joshi, V.V.Mahajan, Process Equipment Design, Macmilan India Ltd.
11. S.D.Dawande, Process Design of Equipments (vol 1and2) Central Techno Publications, Nagpur.
12. J.H.Perry, Chemical Engineer's Hand Book, Mcgraw Hill, New Delhi
13. H.C.Vogel, Woyes Coulson and Richardson,Principles, Process Design of Equipment, (vol 6).

Term Work shall be based on the following assignments:

1. Design of Bioreactors and Scale up.
2. Types of Bioreactors by taking example of product produced.
3. Solid state fermenter with example of bioproduct produced.
4. Bioreactor Design consideration.
5. Pipe joints and types of pipe joints.
6. Process design of bioreaction vessel.
7. Design of Agitators.
8. Types of Agitators.

2. BIOPROCESS MODELING AND SIMULATIONS

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 25 Marks
Term Work: 25 Marks

Unit I

Introduction to modeling:

Introduction: Role of process dynamics and control, historical background, Laws and Languages of process control, Mathematical Modeling of Bioprocess Engineering System: Fundamentals uses of mathematical model, scope of coverage, principles of formulation; Fundamental Laws of Modeling: continuity equation, energy equation,

equation of motion, transport equation, equation of state, phase and chemical equilibrium, chemical kinetics;
Lumped parameter and distributor parameters.

(10 Hrs, 20 Marks)

Unit II

Study of mathematical models of Biochemical Engineering Systems:
Introduction, modeling of CSTRs (isothermal, constant hold up, variable hold up), Batch reactors, non isothermal CSTR, Plug flow reactor, Fluidized bed reactor, Reactors used in effluent treatments, Trickle bed reactor, Fermenter.

(10 Hrs, 20 Marks)

Unit III

Computer aided design of heat and mass transfer equipment:
Batch distillation with hold up, Ideal binary distillation column, Multicomponent nonideal distillation column, Reactor with mass transfer, Design of shell and tube heat exchangers, Double pipe heat exchangers, Design of gas dryer.

(10 Hrs, 20 Marks)

Unit IV

Biological Models:
Modeling of gene regulation, Modeling of signal transduction in prokaryotes and eukaryotes, Models for inheritance, Genetic inbreeding model, Simple logistic models, Simple prey predator models, Volterra's model of an interacting species, Microbial population models (growth model, product formation), Pharmaceutical models, Blood glucose in diabetic patients.

(10 Hrs, 20 Marks)

Unit V

Simulation:
Introduction, Computer programming, Computational methods, Runga-Kutta Method, Newton Raphson Method; Simulation of reactors, Simulation of Double pipe and Shell tube heat exchangers, Simulation for catalyst surface temperature, Simulation of rotary dryer.

(10 Hrs, 20 Marks)

REFERENCES:

1. Luyben W.L. "Process Modeling Simulation and Control for Chemical Engineers", McGraw Hill, 1988.
2. Chapra S.C., R.P. Canale, "Numerical Methods for Engineers", Tata-McGraw Hill Publications.
3. Franks R.E.G., "Modeling and Simulation in Chemical Engineering", Wiely Instscience, NY
4. John Ingam, Irving J. Dunn., "Chemical Engineering Dynamic Modeling with PC simulation", VCH Publishers.
5. J.R. Leigh, Modeling and Control of Fermentation Processes, Peter Peregrinus, London, 1987.
6. J.N.Kapur, Mathematical Models in Biology and Medicine.
7. Cooney and Humphery, Comprehensive Biotechnology,Volume-2,Elsevier Publication.

8. James E. Bailey, David F. Ollis, Biochemical Engineering fundamental, Mcgraw –Hill, International edition.
9. Pevzner, Computational Molecular Biology- An Algorithmic Approach, PHI, New Delhi.
10. Setubal, Introduction to Computational Molecular Biology, Cengage Learning PVT.
11. Vose, Simple Genetic Algorithms, The- Foundations and Theory, PHI, New Delhi.

Practical and Term work: Practical and term work shall consist of minimum eight experiments from list given below.

1) CAD of shell and tube exchanger.
2) CAD of adsorption column.
3) CAD of single effect evaporator.
4) Computer controlled heat exchanger.
5) CAD for rotary dryer.
6) Simulation of temperature on surface catalyst.
7) Simulation of reactor design.
8) Simulation of ammonia production system.
9) Modeling and simulation of protein.
10) Drug designing.

3. BIOSEPARATION PROCESSES

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit I

Introduction and separation of particles:

Role and importance of downstream processing in biotechnology, characteristics of biological mixtures (broth), criteria of recovery process, process design criteria.

Separation of particles:

Introduction, filtration, filter media, theory of filtration, types of filters (vacuum filter, plate and frame filter, leaf filter),centrifugation, theory of centrifugation, types of centrifuge (tubular bowl centrifuge, basket centrifuge, ultra centrifuge), sedimentation, precipitation and flocculation.

(10 Hrs, 20 Marks)

Unit II

Cell disruption methods:

Introduction, types of intracellular products and importance, methods of cell disruption, physico-mechanical cell disruption: liquid shear (high pressure homogenizer), solid shear agitation and abrasives (bead mill, kinetics of bead mill), freezing - thawing, ultrasonication (ultrasonic vibrators), thermal shock, osmotic shock, chemical treatment: alkali treatment, detergent solubilization, lipid solubilization, enzymatic method.

(10 Hrs, 20 Marks)

Unit III

Extraction and Concentration:

Extraction, modes of extraction, liquid-liquid extraction, two phase aqueous extraction, super critical extraction, solvent recovery, extraction application.

Concentration of products:

Evaporation, types of evaporation, membrane process, design and configuration of membrane separator equipment, ultrafiltration, reverse osmosis, dialysis, nanofiltration, sorption, sorption mechanism, materials of sorption, modes of operation in sorption process, adsorption.

(10 Hrs, 20 Marks)

Unit IV

Purification of product:

Fractional precipitation, Chromatography: Types of chromatography: Adsorption, Ion exchange, Gel permeation, Affinity, Molecular Exclusion, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC); Crystallization, Drying, types of drying (spray drying, vacuum drying, freeze drying), Electrophoresis: Theory of electrophoresis, gel electrophoresis, SDS-page electrophoresis, isoelectric focusing, immunoelectrophoresis.

(10 Hrs, 20 Marks)

Unit V

Formulation and Case studies:

Introduction, importance of formulation, formulation of baker's yeast, enzymes (glucose isomerase, detergent enzymes), formulation of pharmaceutical products, application research, Granulation: wet granulation, dry granulation or slugging, Tabletting: compressed tablets, tablet formulation, coating, pills, capsules, Case studies of recovery process of penicillin, cephatomycin, nuclease, citric acid, proteins, etc.

(10 Hrs, 20 Marks)

REFERENCES:

1. Biotal series, Product Recovery in Bioprocess Technology, Elsevier Publisher
2. Murray Moo-Young, Comprehensive Biotechnology (Vol: 1), Pergamon Press, An Imprint of Elsevier.
3. Michael R Ladisch, Bioseparation Engineering Principles, Practice and Economics, Wiley-Inter science
4. Syed Tanveer Ahmad Inamdar, Biochemical Engineering Principles and Concepts, , PHI Publication
5. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology.
6. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Aditya Books (P) Ltd, New Delhi
7. Belter P.A. and Cussier E, Bioseparations, Wiley, 1985.

Term Work shall be based on the following assignments:

1. Role and importance of downstream processing in biotechnology.
2. Separation of particles.
3. Cell disruption methods.
4. Extraction methods.
5. Concentration of products.
6. Chromatography and its types.

7. Electrophoresis and its types.
8. Case studies of recovery process of some bioproducts.

ELECTIVE – I
1. ADVANCED BIOMATERIALS

Teaching Scheme
Theory: 4 Hours/Week

Examination Scheme
Paper: 100 Marks (3Hrs)

Unit-I

Applications of biomaterial, tissue engineering for artificial organs, Types of biomaterials and their applications for the human body, issues of biocompatibility and its evaluation, Surface characterization of biomaterials, biomaterials-blood (bio-fluid) interface, Surface modification for improved compatibility.

(10 Hrs,20 Marks)

Unit-II

Biomaterials in cardiovascular System: Collagen hyaluronic acid and other biopolymer applications, Cardiovascular implant biomaterials: artificial heart valves, Mechanicals and bioprosthetic valves; Vessel grafts, Endothelial cell seeding as a surface modification of biomaterials.

Orthopedic implant materials: Materials for reconstruction of cartilage, ligaments and tendons, Bone replacement and bone cement, Artificial joint replacement.

(10 Hrs, 20 Marks)

Unit-III

Artificial red blood cells, artificial lung surfactants, artificial saliva, artificial synovial fluid, dialysis membranes, artificial liver, artificial pancreas, biodegradable block copolymers and their applications for drug delivery materials used for neuronal reconstruction and regeneration.

(10 Hrs,20 Marks)

Unit- IV

Polhydroxyallalkaloids and polylactides, Biodegradable plastic: characteristics, production and application.

Cyclodextrins: Properties, production and applications.

Biomaterials for development of biosensors enzymes, pigments etc.

(10 Hrs,20 Marks)

Unit - V

Bionanomaterials: Silver and Gold nanoparticles, other nanoparticles, its biological properties, its production, agents for its dispersion and application.

Ophthalmology: Artificial cornea, intraocular lenses, artificial tears, Tissue engineering and artificial organs, Wound dressings, artificial skin, facial implants, Dental restorative materials, implanted dental interfaced.

(10 Hrs,20 Marks)

REFERENCES:

1. D.L. Wise et al. (Eds.): "Encyclopedic Handbook of Biomaterials and Bioengineering (4Vols.)", Marcel Dekker, New York, 1995.
2. S. Fredrick: "Biomaterials, Medical Devices and Tissue Engineering": An Integrated Approach. Chapman and Hall, 1994.
3. L.L. Hench, E.C. Ethridge: "Biomaterials", An interfacial Approach. Academic

Press, New York, 1982.
4. S. Frederick, H. Chrstiansen, L. Devid: "Biomaterial Science and Biocompatibility".

ELECTIVE – I
2. PLANT TISSUE CULTURE AND PLANT BIOTECHNOLOGY

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)

Unit I
Introduction to plant tissue culture:
Introduction, history of tissue culture, general techniques (about aseptic conditions), requirements (equipments), media, media constituents, media selection, types of media, totipotency of cells, explant, criteria for selection of explant, surface sterilization of explant, classification of tissue culture, callus culture, cell suspension culture, application of callus culture and cell suspension culture, regeneration of plantlet by callus culture.
(10 Hrs, 20 Marks)

Unit II
Tissue culture methods:
Meristem culture, anther culture, ovary culture, embryo culture, somatic hybridization, protoplast culture (isolation of protoplast, purification of protoplast and culture media of protoplast), protoplast fusion methods, Micro propagation, Somatic embryogenesis, somaclonal variation, haploid plants, cybrids, Gynogenesis, synthetic seeds and preservatives, cryopreservation.
(10 Hrs, 20 Marks)

Unit III
Plant Biotechnology:
Plant viruses, classification of plant viruses, virus as a tool to deliver foreign DNA, gene construction of plants, vectors for production of transgenic plant, transformation techniques: Agro bacterium mediated gene transfer, Agro infection, direct gene transfer method; integration of the transgenes, analysis of transgene integration, Nitrogen fixation, nif gene.
(10 Hrs, 20 Marks)

Unit IV
Transgenic plants I:
Introduction, characteristics of transgenic plants, herbicide resistance, insect resistance, virus resistance, drought resistance, microbial disease resistance, stress tolerance, genetic manipulation of flowers pigmentation, fruit ripening and flower wilting.
(10 Hrs, 20 Marks)

Unit V
Transgenic plants II:
Modification of starch, plant nutritional content, food plant taste and appearance, oil and seed protein quality, male sterility, biochemical production, pharmaceutical products, plant derived vaccines, biofertilizers.
(10 Hrs, 20 Marks)

REFERENCES:

1. R.A.Dixon and Gonzales, Plant cell culture : A Practical Approach, IRL Press.
2. S.S.Purohit, Biotechnology Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
3. B.D.Singh, Biotechnology-Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008.
4. S.S.Bhojwani and M.K.Razdan, Plant Tissue Culture : Theory and Practical, (1996) Elsevier, Amsterdam.
5. J.Hammond,P.McGarvey and V.Yusibov (Eds.), Plant Biotechnology New Products and Applications, Springer.
6. S.B Primrose and R.M.Twyman, Principles of Gene Manipulation and Genomics, Blackwell publishing, 7th edition, 2006.
7. Bernard R. Glick, Molecular Biotechnology 3rd edition, CBS Publishers Distributors.

ELECTIVE – I
3. PROTEIN ENGINEERING

Teaching Scheme: Examination Scheme:
Lectures: 4 Hrs. / Week Paper: 100 Marks (3 Hrs)

Unit I

Introduction to Proteins:

Introduction, biosynthesis of protein, post translation modification, primary, secondary, tertiary and quaternary structure of proteins, conformational analysis and forces that determine protein structure, energy status of a protein , effect of amino acids on structure of proteins with example, structure and functional relationship.

(10 Hrs, 20 Marks)

Unit II

Structure Determination:

Methods of protein isolation, purification and quantification, physical methods to determine protein structure: X-ray crystallography, NMR spectroscopy; amino acid sequencing methods.

(10 Hrs, 20 Marks)

Unit III

Protein Engineering:

Mutagenesis, types of mutagenesis, site directed mutagenesis, protein engineering, modifications to 3D structure of proteins, design and synthesis of peptides, PCR, PCR in site directed mutagenesis.

(10 Hrs, 20 Marks)

Unit IV

Application of Protein Engineering:

Specific examples of engineered enzymes, Tryesyl tRNA synthetase, Dihydrosolate reductase, Subtilisin, Pepsin class of enzymes, Lysozyme, charging tRNA, Peptide vaccines, Engineered Proteins in medical application, Chemical modifications: phosphorylation, glycosylation, methylation, formylation, Application of engineered proteins.

(10 Hrs, 20 Marks)

Unit V

Protein Modeling and Drug Design:

Protein database, structure database, alignment methods to determine protein function and similarity, structure prediction, molecular modeling, structural similarities and super-imposition techniques, Molecular interactions: docking, calculation of molecular properties, energy calculation in docking, introduction to software used in protein modeling and drug design.

(10 Hrs, 20 Marks)

REFERENCES:

1. Klaus Demobowsky, "Novel Therapeutic Proteins": Wiley Publications.
2. Messer- Schmidt, "Handbook of Metaloproteins" – Wiley Publications.
3. Ronald Kellner et al., "Microcharacterisation 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.
7. Buchanan B.B. Grussem. W. and Jones. R.L. 2000. 'Biochemistry and Molecular Biology of Plants". American Society of Plant Physiologists, Maryland, USA.

ELECTIVE – I
4. FOOD BIOTECHNOLOGY

Teaching Scheme: Examination Scheme:

Lectures: 4 Hrs. / Week Paper: 100 Marks (3 Hrs)

Unit I:

Introduction, world food requirement, aims of food biotechnology, interdisciplinary approach, constituents of food, functional properties of dietary carbohydrates and their sources, fatty acids in food, functions of dietary proteins and their sources, dietary requirement of vitamins, Food quality: evaluation (sensory) of food quality, quality factors for the consumers safety, food safety standards.

(10 Hrs, 20 Marks)

Unit II:

Microorganisms in food:

Types of microorganisms in food, role and significance of micro organisms in foods, factors influencing microbial activity.

Microbial examination of foods, food borne diseases: food infection, viral infections, food borne parasites, food intoxication.

(10 Hrs, 20 Marks)

Unit III:

Food spoilage and Preservation:

Food fit for consumption, deterioration of food quality, causes of food spoilage, spoilage of various foods and food products; food preservation using high temperature, evaporation ,drying, low temperature and irradiation.

(10 Hrs, 20 Marks)

Unit IV:
Food Biotechnology:
Food fermentation, microbial culture in food industry, fermented dairy products (milk, yogurt and cheese), fermented meat products and vegetable products, fermentation for flavor production, idali, vinegar, colors, vitamins, beverage, single cell proteins, sauerkraut, deoxygenation and desugaring by glucose oxidase.

(10 Hrs, 20 Marks)

Unit V:
Unit operations:
Food engineering operations, size reduction, screening, mixing, emulsification, filtration, membrane separation, centrifugation, extraction, expression, crystallization, heat processing.

(10 Hrs, 20 Marks)

REFERENCE:

1. B. Sivashankar, Food Processing and Preservation, Prentice Hall ,India.
2. Powar and Daginawala, General Microbiology (vol 2), Himalaya Publishing House.
3. Murray Moo-Young, Comprehensive Biotechnology (Vol: 3), Pergamon Press, An imprint of Elsevier.
4. S.S. Purohit, Microbiology: Fundamentals and Application, Agrobios India.
5. Fraizer, Food Microbiology ,TMH publication
6. Hiller, Genetic Engineering of Food: Detection of Genetic Modifications, Willy Publication.

5. FERMENTATION BIOTECHNOLOGY-II

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 50 Marks
Term Work: 25 Marks

Unit I
Beverage products:
Fermentative production Alcoholic beverages: Beer, Wine, Rum, Gin, Whisky, Brandy, Champaign.
Industrial Chemicals:
Fermentative production of citric acid, acetic acid, lactic acid, ethanol, acetone and butanol, gluconic and itaconic acid, fumaric acid, steroid biotransformation.

(10 Hrs, 20 Marks)

Unit II
Fermentation of food products:
Fermentative production of food products: cheese and types of cheese, fermented soyabean foods, biomass production (single cell protein, baker's yeast), fermented dairy products like yogurt, cultured buttermilk;
Microbial flavors and fragrances (methyl ketones, lactones, butyric acid, terpenes and terpene transformation).
Biofertilizers: Production of Rhizobium, Bacillus thuringienesis, Trichoderma viride.

(10 Hrs, 20 Marks)

Unit III

Biomolecules:

Enzyme production- Amylases, Proteolytic enzymes, Invertase enzyme, Pectinases, Lipases; Vitamins: Vitamine B12, Riboflavin, Vitamin A, Amino acid production: L-Glutamic acid, L-Lysine, L-Threonine; Microbial pigments, Microbial polysaccharides.

(10 Hrs, 20 Marks)

Unit IV

Biopharmaceuticals and Biotransformation:

Production of penicillin, B-Lactum antibiotics, Streptomycin, Cephalosporins, Aminoglycoside, Tetracyclines, Steroid Biotransformation.

(10 Hrs, 20 Marks)

Unit 5

Important products through r-DNA technology:

Hepatitis B, vaccine, interferons, Insulin, somatotrophic hormone, therapeutic proteins Vaccines.

Production of biodiesel and biogas, Biological production of hydrogen and biofuel cells Biological waste treatment (utilization of mixed culture).

(10 Hrs, 20 Marks)

REFERENCES:

1. L.E.Casida,JR ,Industrial Microbiology, New Age International (P) Ltd Publication.
2. Jayanta Achrekar, Fermentation Biotechnology, Dominant Publishers and Distributors
3. D.Lanch,Drew,Wang, Comprehensive Biotechnology-Volume 3,Elsevier Publication.
4. B.D.Singh, Biotechnology, Kalyani Publication.
5. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering: Basic Concepts, Prentice Hall India Pvt. Ltd., New Delhi.
6. Prescot and Dun, Industrial Microbiology, McGraw-Hill Book Company, Inc. New York.

Practical and Term work: Practical and term work shall consist of minimum eight experiments from list given below.

1. Study of growth curve of microorganisms.
2. Production of ethyl alcohol using yeast.
3. Citric acid production using Aspergillus niger.
4. Penicillin production using Penicillium crysogenum.
5. Production of enzyme by solid state fermentation.
6. Isolation of bacterial pigments.
7. Production of enzyme by submerged fermenter.
8. Production of bakers yeast (biomass production).
9. Vinegar production by fermentation.
10. Analysis of molasses.
11. Analysis of finished product (rectified spirit, beer, etc.).

6. PROJECT-I

Teaching Scheme: Examination Scheme:
Practical: 2 Hrs./ Week Oral : 25 Marks
Term Work: 25 Marks

The project topic shall consists of either some investigation work or design problem or experimental set up of some development work or prototype equipment or dissertation related to field of Biotechnology, Biochemical Engineering and allied fields.
Project shall be taken in the beginning of the seventh term in consultation with concerned guide and must be completed in eighth term. The project proposal must be submitted in the beginning of the seventh term by every student or a group of students (not more than five students in a group).
The students shall submit the report to the corresponding guide, present their work in due time based on following points,

- Introduction.
- Literature survey.
- Physical / chemical properties etc.
- Experimental setup and procedure.
- Extent of project completed.

Presentation can be performed with OHP slides / LCD.
The progress of the project shall be evaluated by a committee of internal teachers which shall include concerned guide also and shall award the term work marks.
The oral examination of the project shall be conducted by concerned guide and external examiner jointly.

7. SEMINAR

Teaching Scheme: Examination Scheme:
Practical: 2 Hrs./ Week Term Work: 25 Marks

During seventh term, every student individually will study a topic assigned to him and submit a report in a typed form and shall deliver a short lecture / seminar on the topic at the time of seminar oral examination .The topic assigned will be related to the field of Biotechnology, Biochemical Engineering and allied fields.

The students shall deliver the seminar (10 to 15 minutes) and submit the seminar report to the staff member on different technical subjects during the semester. The assessment of the term work shall be based on the: -

1. Attendance to the seminar
2. Performance of the seminar delivery
3. Seminar reports and
4. Viva voce during the seminar.

The staff member/members shall guide the students in:

1. Selecting the seminar topic.
2. Information retrieval (literature survey)
    a) Source of Information i.e. names of the journals, reports, books etc.
    b) Searching for the information i.e. referring to chemical abstracts etc.

3. Preparing the seminar report
4. Delivering the seminar

The oral examination shall be conducted by a committee of teachers internally which shall include the concerned guide also and shall award the oral marks (in the seventh term / at the end of seventh term).

B.E. BIOTECH. TERM II.

1. BIOPROCESS ENGINEERING – II

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 25 Marks
Term Work: 25 Marks

Unit-I

Plant Tissue Engineering-I:
Introduction to tissue engineering, media components (micro and macro nutrients) and preparation, media selection, cellular totipotency,practical application of cellular totipotency, criteria for selection of explant, classification of tissue culture, callus culture, cell suspension culture, application of callus culture and cell suspension culture, single cell culture, meristem culture.

(10 Hrs, 20 Marks)

Unit-II

Plant Tissue Engineering-II:
Bioprocess consideration in using plant cell cultures, bioreactors for suspension cultures, bioreactors for organized tissue, production of secondary metabolites, anther culture, ovary culture, embryo culture, protoplast culture, synthetic seeds and preservations.

(10 Hrs, 20 Marks)

Unit-III

Animal Tissue Engineering-I:
Introduction, Culture environment: substrate, gas phase, media, constituents of media, types of media; isolation of tissue, primary culture, culturing and maintenance of different cell lines, cloning and selection of specific cell types, stem cell isolation and culture, instability, variation and preserving of cell lines, short term lymphocyte culture, fibroblast cultures from chick embryo, epithelial cells culture.

(10 Hrs, 20 Marks)

Unit-IV

Animal Tissue Engineering-II:
Bioreactors considerations for animal cell cultures, Bioreactors for animal cell lines: Monolayer culture (Air lift fermenter, Roux flask, Roller bottle, Hollow fiber cartridge), Suspension cultures (stirred tank bioreactors, packed glass bead reactors), Immobilized cell reactors; Products of animal cell cultures, culture of tumor tissue. Three dimensional culture systems: organ culture, Histotypic culture; a brief about transgenic animals.

(10 Hrs, 20 Marks)

Unit V

Instrumentation and control:
Introduction, methods of measuring process variables, In-line measurements: parameters like temperature, pressure, agitator speed and power consumption, foam detection, liquid and gas flow rates, volume, chemical environment like pH, dissolved oxygen ,dissolved CO_2, redox probe, ion probe, microbial biomass; On line measurement: Ion specific

sensors, enzyme and microbial electrodes, infrared spectroscopy, mass spectrometers; off line analytical methods, computer applications in fermentation technology, Biosensors.

(10 Hrs, 20 Marks)

REFERENCES:

1. R.A.Dixon and Gonzales, Plant Cell Culture : A Practical Approach, IRL Press.
2. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
3. B.D.Singh, Biotechnology: Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008.
4. S.S.Bhojwani and M.K.Razdan, Plant Tissue Culture : Theory and Practical, (1996) Elsevier, Amsterdam
5. J.Hammond,P.McGarvey and V.Yusibov (Eds.), Plant Biotechnology New Products and Applications, Springer.
6. S.B Primrose and R.M.Twyman, Principles of Gene Manipulation and Genomics Blackwell Publication, 7th Edition, 2006.
7. Bernard R. Glick, Molecular Biotechnology 3rd edition, CBS Publishers and Distributors.
7. P.F.Stanbury, A.Whitkar and S.J.Hall, Principles of Fermentation Technology, Aditya Book House, New Delhi.
9. R. Ian Freshney,Culture of Animal Cells: A Manual of Basic Technique, A John Wiley and Sons Publications

Practical and Term work: Practical and term work shall consist of minimum eight experiments from list given below.

1. Growth kinetics of microorganisms using shake flask method.
2. Determination of specific thermal death rate constant (Ka).
3. Determination of Volumetric oxygen transfer coefficient (K_La), effect of aeration and agitation speed.
4. Preparation of Immobilized enzymes and cells and evaluation of kinetic parameters.
5. Kinetics study of Product formation.
6. Effect of substrate and product concentration on biomass yield for bakers yeast production.
7. Studies on settling characteristics of various microbial cultures.
8. Explant preparation and their inoculation on suitable plant growth media.
9. Callus induction technique and regeneration of plant from callus culture.
10. Artificial seed production.
11. Shake flask studies of plant cell culture.

2. BIOPOCESS ENGINEERING AND ECONOMICS

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 25 Marks
Term Work: 25 Marks

Unit I

Bio process Design Considerations**:**

Technical feasibility survey, process development, flow diagram, equipment design and specifications, marketability of product, availability of technology, raw material equipment, human resources, land and utilities, site characteristics, waste disposal, government regulations and other legal restrictions, community factors and other factors affecting investment and production cost, Indian Bioprocess Industry - Current Status and Trends.

(10 Hrs, 20 Marks)

Unit II

Cost Estimation:

Factors affecting investment and production cost, capital investment, fixed investment and working capital, estimating equipment cost by 6/10 factor rule, method of estimating capital investment. Different costs involved in total product cost, computer automization in costing.

(10 Hrs, 20 Marks)

Unit III

Investment Cost and Profitability:

Interest and investment cost, type of interest, types of taxes and tax returns, types of insurance and legal responsibility, depreciation, types of depreciation, methods of determining depreciation.

Profitability, mathematical methods of profitability evaluation, cash flow diagram, break even analysis, balance sheet, pricing issue method and income statement.

(10 Hrs, 20 Marks)

Unit IV

Fermentation Economics:

Introduction, isolation of microorganisms of potential industrial interest, strain improvement, market potential, effects of legislation on production of antibiotics and recombinant proteins, plant and equipment, media, air sterilization, heating and cooling, aeration and agitation, batch process cycle times, continuous culture, recovery costs, water usage and recycling, effluent treatment.

(10 Hrs, 20 Marks)

Unit V

Bioproduct Economics:

Bioproduct regulation, Fermentation process economics: A complete example, Economic consideration of commercial Bioproduct: Enzymes, Proteins via rDNA, Antibiotics, Vitamins, Alkaloids, Nucleosides, Steroids, Monoclonal antibodies, Brewing and wine making, Fuel Alcohol Production, Organic and Amino acid manufacture, Single cell protein, Anaerobic methane production.

(10 Hrs, 20 Marks)

REFERENCES:

1. Peter M.S. Timmerhaus K.D. Plant Design and Economics for Chemical Engineers. McGraw Hill.
2. Vilbrandt F.C. and C.E. Dryden , Chemical Plant Design. McGraw Hill
3. T.R. Banga and S.C.Sharma, Industrial Organization and Engineering Economics, Khanna Publications, New Delhi.
4. O.P.Khanna Industrial Engineering and Management, Dhanpat Rai Publications Pvt. Ltd. New Delhi.
5. Dewett and Varma, Elementary Economic Theory, S Chand and Company Ltd New Delhi
6. James E. Bailey, David F. Ollis, Biochemical Engineering Fundamentals, Mc Graw-Hill Book Company.
7. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Aditya Book Private Limited.

TERM WORK: Term work shall be based on any eight of the following:

1. Indian Bioprocess (biotech) industry.
2. Location of bioprocess plant.
3. Cost estimation.
4. Interest and investment cost.
5. Taxes and insurance.
6. Profitability.
7. Break even analysis.
8. Fermentation economics.
9. Bioproduct economics.

3. BIOINFORMATICS

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 25 Marks
Term Work: 25 Marks

Unit -I

Introduction:

Entropy and information, Shannon's formula, Ergodic process-Redundancy concepts, Introduction to bioinformatics, bioinformatics and internet, DNA sequencing methods.

Databases:

Introduction, primary and secondary databases, format v/s contents, the database, the Gen bank flat files and its format, database at NCBI, Databases : DDBJ, EMBL, Genbank, submitting DNA sequence to database; Structure database: PDB, Molecular modeling database at NCBI, structure file format, Database structure viewers.

(10 Hrs, 20 Marks)

Unit-II

Sequence alignment:

Introduction, types of sequence alignment, evolutionary basis of sequence alignment, Algorithms for sequence alignment: Needlemen-Wunsch and Smith-Waterman

algorithm, methods of pair wise sequence alignment, Database similarity searching: FASTA, BLAST, Substitution Score and Gap penalties, PAM matrix, multiple sequence alignment, Hidden markov models and threading methods.

(10 Hrs, 20 Marks)

Unit-III

Phylogenetic analysis:

Introduction, elements of phylogenetic models, phylogenic data analysis, relation between Phylogenetic analysis and multiple sequence alignment, evolutionary trees, methods for Phylogenetic prediction: Maximum Parsimony method, Distance methods, Maximum likelihood approach, Phylogenetic software.

(10 Hrs, 20 Marks)

Unit-IV

Gene prediction:

Introduction, open reading frame based gene prediction, procedure for gene prediction, gene prediction in microbial genomes, gene prediction in eukaryotes, neural networks and pattern, Discrimination methods, Promoter prediction in E.Coli, Promoter prediction in eukaryotes, gene finding methods: GRAIL, GENSCAN, PROCRUSTES, Gene parser.

(10 Hrs, 20 Marks)

Unit-V

Structure prediction:

Prediction of RNA structure:-

Introduction, features of RNA secondary and tertiary structure, sequence and base pairing patterns for structure prediction, methods predicting RNA structure: Energy minimization and identification of base covariation.

Prediction of protein structure :-

Introduction, protein structure description, classes of protein structure, protein structure classification in databases, structural alignment methods, protein structure prediction by amino acid sequence: use of sequence patterns, prediction of secondary structure, prediction of 3D structure.

(10 Hrs, 20 Marks)

REFERENCES:

1. Andreas D. Boxevanis, Bioinformatics, Wiley International.
2. David W. Mount, Bioinformatics: Sequence and Genome analysis, Cold Spring Harbour.
3. T.K.Attwood and Parry – Smith D.J, Introduction to Bio Informatics, Pearson Education Ltd, South Asia.
4. Vittal.R.Srinivas, Bioinformatics: A Modern Approach, PHI.
5. S.C.Rastogi, N.Mendiratta, P.Rastogi, Bioinformatics: Methods and Applications, PHI.

Practical and Term work: Practical and term work shall consist of minimum eight experiments from list given below.

1. Databases search: protein and nucleic acid database.
2. Restriction mapping.

3. Sequence (FASTA and BLAST) searches.
4. Pair wise comparison of sequences.
5. Multiple alignments of sequences.
6. Phylogenetic analysis.
7. Gene structure prediction.
8. Protein database retrieval and visualization.
9. RNA structure prediction.
10. Protein structure prediction.

ELECTIVE II
1. METABOLIC ENGINEERING

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit-I

Basic concepts of metabolic engineering, overview of cellular metabolism, introduction to various metabolic pathways, primary and secondary metabolites, medical and agriculture, importance of secondary metabolites.

(10 Hrs, 20 Marks)

Unit-II
Metabolic Regulation:
Metabolic regulation of genome level, Jacob and Monad model, coordinate regulation of prokaryotic gene expression, lactose operon, tryptophan operon, feed back regulation, cumulative feed back regulation, regulation of gene expression.

(10 Hrs, 20 Marks)

Unit-III
Computational Methods for Pathways:
Introduction, Analysis of pathways: metabolic pathways, genetic pathways, signaling pathways, pathway resources, metabolic control analysis, simulation of cellular activities, biological markup languages.

(10 Hrs, 20 Marks)

Unit-IV
Metabolic Flux:
Metabolic pathway synthesis algorithms, metabolic flux analysis and its application, mathematical calculation for the flow of carbon and nitrogen fluxes, methods for experimental determination of metabolic fluxes by isotope labeling, stereochemistry of regulatory molecules, concepts of regulatory analogs.

(10 Hrs, 20 Marks)

Unit-V

Different models for cellular reactions, genetic regulation of metabolic fluxes, examples of metabolic pathway manipulations and engineering, analysis of metabolic control and structure metabolic networks, thermodynamics of cellular processes.

(10 Hrs, 20 Marks)

REFERENCE:

1. James Bower and Itamid Bodour, Computational modeling of Genetic and Biochemical Networks,
2. Valino, Metabolic Flux Analysis.
3. Vittal.R.Srinivas, Bioinformatics: A Modern Approach, PHI.
4. S.C.Rastogi, N.Mendiratta, P.Rastogi, Bioinformatics: Methods and Applications, PHI.
5. D. Voet and J.G. Voet 1990, Biochemistry, John Willey and Sons.
6. Szallasi, Stelling, Periwal, System Modeling in Cellular Biology: From Concepts to Nuts and Bolts, PHI, New Delhi.

TERM WORK: Term work shall be based on any eight of the following:

1. Overview of cellular metabolism and metabolic pathway.
2. Primary and Secondary metabolites.
3. Metabolic regulation.
4. Regulation of gene expression.
5. Computational analysis of metabolic pathway.
6. Metabolic flux analysis.
7. Metabolic pathway synthesis algorithms.
8. Examples of metabolic pathway engineering.

ELECTIVE II
2. BIOSAFETY AND BIOETHICS

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit I

Biosafety:

Introduction, objectives of biosafety guidelines, risk assessment, risk regulation, containment, planned introduction of genetically modified organism, biosafety during industrial production, Biosafety levels: experiment with microorganism, research involving plants, research involving animals, Good manufacturing and Good Laboratory practices.

(10 Hrs, 20 Marks)

Unit II

Biosafety regulation and guidelines:

Biosafety guidelines and regulation, biosafety guidelines in India, National and International guidelines with regard to rDNA technology, transgenic science, GM crops,

hazardous material from bioprocess, pharmaceutical product; GM food debate, Biosafety assessment procedures for Biotech food and related products, ecological safety assessment of recombinant organism and transgenic crops, Bioterrorism and convention on biological weapons.

(10 Hrs, 20 Marks)

Unit III

Introduction:

Bioethics: Legality, morality and ethics, principle of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc; Biotechnology and society: Introduction to science, technology and society, public acceptance issues in biotechnology

Ethical conflicts in biotechnology: Fear of unknown, black face of biotechnology? When transgenes wander, should we worry? BT cotton creating resistance to biotechnology? Conflicts of BT cotton, some case studies, unequal distribution of risk and benefit of biotechnology.

(10 Hrs, 20 Marks)

Unit IV

Bioethics in animal genetic engineering: Introduction, Issues concern to use of animals, case studies, Animal as a tennis ball? Gene therapy and transgenic animal. Should animal be patentable?

Bioethics in plant genetic Engineering, bioethics and moral concern, Gene flow in crops, BT-cotton case studies, transgenic plants are not absolutely safe, Public education of biotechnology.

Bioethics in Microbial Technology.

(10 Hrs, 20 Marks)

Unit V

Intellectual property rights:

Introduction, IPR in India , intellectual property , protection of IPR : Trade secret, Patent, Copyright, Plant variety protection , International Harmonization of patent laws: Trips, India and Trips ,WTO-GATT; methods of application of patent, protection of biological inventions, plant breeders right ,examples of patents in biotechnology, choice of IPR protection, management of IPR, benefits and problems from IPR, Indian response to the IPR upheaval.

(10 Hrs, 20 Marks)

REFERENCES:

1. Thomas J A Fucnh – Biotechnology and Safety Assessment, Academic Press.
2. Fleming D A, Hunt D L, Biological Safety Principles and Practices, Assm Press Washington.
3. Singh K ,Intellectual Property Rights on Biotechnology, BCIL New Delhi.
4. Moo-Young ,Compressive Biotechnology Vol.4, Elsevier Publisher.
5. B D Singh , Biotechnology, Kalyani Publishers.
6. S S Purohit, Biotechnology, Agro Bios.

TERM WORK: Term work shall be based on any eight of the following:

1. Biosafety, risk assessment and regulation.
2. Good manufacturing and Good Laboratory practices.
3. Biosafety guidelines and regulation.
4. National and International biosafety guidelines.

5. Bioethics and public acceptance issues in biotechnology.
6. Bioethics in animal and plant genetic engineering with Case studies.
7. Intellectual property rights.
8. Examples of patent in biotechnology.

ELECTIVE II
3. BIOMEDICAL FLUID DYNAMICS

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit-I
Introduction to fluid mechanics: Fluid properties, basic laws governing conservation of mass momentum and energy; Laminar flow, Couette flow and Hagen-Poiseulille equation, turbulent flow.

(10 Hrs,20 Marks)

Unit-II
Flow dynamics study of circulatory system, heart and blood vessels, anatomy and physiological considerations

(10 Hrs,20 Marks)

Unit-III
Components and functions of arterial and venous systems; Lymphatic system; Body fluids and their motions; Flows of Newtonian and non-Newtonian fluids in rigid tubes, flexible tubes and collapsible tubes.

(10 Hrs,20 Marks)

Unit-IV
Blood flow through arteries and veins; Holt and Conrad's experimental investigations. Kinetic energy, flow, pressure-flow, pressure-flow relations in vascular beds.

(10 Hrs,20 Marks)

Unit-V
Cardiac cycle; Cardiac value dysfunctions; Blood pressure,regulation and controlling factors; Coronary Circulation, heart failure.

(10 Hrs,20 Marks)

REFERENCES:

1. J.F. Green, "Fundamental Cardiovascular and Pulmonary Physiology", Lea and Febiger, Philadelphia, 1982.
2. C.A. Keele, E. Neil and N. Joels: Samson Wright's Applied Physiology 13th Ed., Oxford University Press, Delhi 1982.
3. A. Noordergraft: 1978., "Circulatory System Dynamics" Academic Press, New York,
4. R.R. Puniyani: , , 1996. , "Clinical Haemorheology" New Age Int. Publishers. New Delhi.

TERM WORK: Term work shall be based on any eight of the following:

1. Introduction to fluid mechanics.
2. Anatomy and physiological of circulatory system.
3. Flow dynamics study of circulatory system.
4. Components and functions of arterial, venous and lymphatic system.
5. Body fluids and their motion.
6. Pressure – flow relations in body fluids flow.
7. Cardiac value dysfunction.
8. Blood pressure regulation and controlling factors.

ELECTIVE II
4. APPLIED GENETIC ENGINEERING.

Teaching Scheme:
Lectures: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 25 Marks

Unit I
Genetic Engineering Techniques:
Blotting methods: Western, Northern and Southern blotting; DNA sequencing methods, synthesis of DNA (gene), PCR, Types of PCR: Inverse, RT-PCR, site directed mutagenesis using PCR, overlap extension PCR, asymmetric PCR, nested PCR, PCR application, Antisense technology, microarrays.

(10 Hrs, 20 Marks)

Unit II
Genomics:
Human genome project, mode of human inheritance, genetic linkage and gene mapping, molecular markers in genome analysis: RFLP, AFLP, RAPD, SCAR, micro satellites, protein based markers; detection of mutations in human genes: single-strand conformation analysis, denaturing gradient gel electrophoresis, heteroduplex analysis, chemical mismatch cleavage, direct DNA sequencing; applications of molecular markers.

(10 Hrs, 20 Marks)

Unit III
Transgenic Animals:
Animal vectors, artificial chromosome (MAC) vectors, transaction methods, embryonic stem cell transfer, detection of transgenic and transgene function, transgenic animals: mice, rabbits, cattle, goat, sheep, pigs and fish; Invitro fertilization and embryo transfer.

(10 Hrs, 20 Marks)

Unit IV
Gene Therapy:
Introduction, types of gene therapy: Somatic and Germline therapy; methods of gene therapy, gene therapy in immuno deficiency disease and cancer, targeting and destroying artificial clotting (thrombosis) by using plasminogen, curing Severe Combined Immunodeficiency (SCID) by Adenosine Deaminase (ADA) gene, breast cancer

treatment (genetically modified antibody), prevention of tissue and organ graft rejection, gene augmentation therapy, gene medicine, transgenic animals as models of human disease.

(10 Hrs, 20 Marks)

Unit V

Genetic Engineering for Human Welfare:

Production of human peptide hormone, insulin, somatotropin, somatostatin, human interferon genes, human growth hormone, tumor necrosis factor alpha, vaccines for hepatitis B virus, vector vaccines, vaccines for rabies, polio virus, foot and mouth disease, malaria vaccines, monoclonal antibodies as therapeutic agents, nucleic acid as therapeutic agents, animal bioreactors and molecular farming, DNA profiling (DNA fingerprinting):methods and applications.

(10 Hrs, 20 Marks)

REFERENCES:

1. S.B.Primrose and R.M.Twyman, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing.
2. Bernard R.Glick and Pasternak , Molecular Biotechnology, CBS publishers Distributors , New Delhi
3. B.D Singh, Biotechnology – Expanding Horizons, Kalyani Publishers.
4. R.C.Dubey, A Textbook of Biotechnology, S.Chand Publishers, New Delhi
5. S.S.Purohit , Biotechnology, Agrobios India.

TERM WORK: Term work shall be based any eight of the following:

1. Genetic Engineering Techniques.
2. PCR and its types, Antisense technology, Microarrays.
3. Molecular markers in genome analysis.
4. Transgenic Animals.
5. Invitro fertilization and embryo transfer.
6. Gene Therapy.
7. Genetic Engineering for Human Welfare.
8. DNA profiling (DNA fingerprinting): methods and applications.

5. PROJECT- II

Teaching Scheme	Examination Scheme
Practical: 4 hrs / week	Oral: 50 Marks
	Term Work: 100 Marks

The students are required to carry out one of the following projects.

1. Processes based Project: Manufacture of Bioproduct.
2. Equipment based Project: Detailed design and fabrication of the equipment for a given capacity.
3. Experimental based Project: Experimental investigation of basic or applied research problem in the field of Microbiology, Immunology, Molecular biology, Bioprocess, Biochemistry, Genetic Engineering, Bioinformatics, Enzyme technology and Environmental Biotechnology.

4. Industrial Problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation under the guidance of a staff member and /or staff members and submit a typed report in duplicate.

The Project Work consists of collection of literature, study of various processes, selection of the process, computation of material and energy balances, process design of important equipments, detailed design of one of the main equipment, plant location and layout, cost estimation, economic analysis, details of experimental set up, analysis of data, pollution control, safety, marketing, conclusions and recommendations, bibliography, etc., as applicable to the individual problem.

The object of the project is to make use of the knowledge gained by the student at various stages of the degree course. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course.

Each group should consist of maximum 5 students. For term-work (Internal) of 100 marks, the assessment should be by conducting frequent written tests, seminars during the year and an oral examination at the end of the year conducted by all the staff members of the department. The Head of the Department should see that the assessment procedure should be the same for all the students of the class. For external 50 marks, the project work shall be assessed by an oral examination by at least two examiners, one internal and one must by external at the end of the year.

The object of the VIVA VOCE examination (Internal and External Orals) is to determine whether the objectives of the project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the project work.

6. INDUSTRIAL VISIT / CASE STUDY

Examination Scheme:
Term Work: 25 Marks

During seventh term, every student shall visit minimum two to three industries or organization pertaining to the Biotechnology arranged by College and accompanied by departmental teachers as per AICTE and University norms. The report of technical visit shall be submitted by every student at the end of eighth term which shall be evaluated by the concerned teachers through internal Viva Voce.