B

Accredited By NAAC

SHIVAJI UNIVERSITY, KOLHAPUR.

Revised Syllabus of

(B.E. Biotechnology Engineering Sem –VII & VIII)

To be introduced from the academic year 2010-11

(i.e. from June 2010) Onwards

(Subject to the modifications will be made from time to time)

SHIVAJI UNUVERSITY, KOLHAPUR

Structure of B. E. (Biotechnology Engg.) Semesters VII & VII

Sr. No.	Name of the Subject	Teaching Scheme				Examination Scheme (Marks)				
		L	T	P	Total	Theory	Term work	POE	OE	Total
1	Bioreaction Engineering	4	-	2	6	100	25	25	--	150
2	Protein Engineering	4	-	-	4	100	25	-	--	125
3	Pharmaceutical Biotechnology	4	-	-	4	100	25	-	--	125
4	Bioprocesses	4	-	2	6	100	25	--	25	150
5	Elective- I	4	-	-	4	100	-	-	--	100
6	Comprehensive tests (On all subjects from S.E.to B.E.-I)	-	-	2	2	-	50	-	--	50
7	Industrial training at end of 6th Semester (4Week)	-	-	-	-	-	50	-	--	50
8	Project Work	-	-	4	4	-	25	--	25	50
	Total	**20**	**-**	**10**	**30**	**500**	**225**	**25**	**50**	**800**

***NOTE: PROJECT WORK SHOULD BE STARTED AT BEGINNING OF SEMESTER-VII**

ELECTIVE-I:

1) Biomedical Engineering

2) Plant Biotechnology

3) Good Manufacturing Practices

4) Environmental Biotechnology

5) Genomics and Proteomics

B.E. Biotechnology Engineering Part-II Semester- VIII

Sr. No.	Name of the Subject	Teaching Scheme				Examination Scheme (Marks)				
		L	T	P	Total	Theory	Term work	POE	OE	Total
1	Bio separation Processes	4	-	2	6	100	25	50	--	175
2	Bioprocess Modeling and Simulation	4	-	2	6	100	25	-	--	125
3	Bioprocess Engineering & Economics	4	-	-	4	100	-	-	--	100
4	Animal Biotechnology	4	-	-	4	100	25	-	--	125
5	Elective- II	4	-	-	4	100	-	-	--	100
6	Seminar-II	-	-	2	2	-	25	-	--	25
7	Project Work	-	-	4	4	-	75	--	75	150
	Total	**20**	**-**	**10**	**30**	**500**	**175**	**50**	**75**	**800**

ELECTIVE-II:

1) Applied Genetic Engineering

2) Food and Dairy Biotechnology

3) Metabolic Engineering

4) Advanced Biomaterials

[Note :- Examination scheme and term work marks strictly as per above structure]

Shivaji University, Kolhapur

B.E. Part – I (Biotechnology Engineering) SEM-VII

1. BIOREACTION ENGINEERING

Hrs/week	Examination Marks
Lectures 4	Theory : 100
Practicals 2	POE : 25
	Term Work : 25

Section -I

Unit 1. Reaction kinetics (10)

Reaction thermodynamics, order and molecularity of reaction, homogeneous and heterogeneous reactions, elementary and non elementary reactions, reaction yield, reaction rate, calculation of reaction rates from experimental data, general reaction kinetics for biological system, production kinetics in cell culture, kinetics of substrate uptake in cell culture, growth kinetics with plasmid instability, kinetics of bisubstrate enzyme reactions, kinetics of enzyme deactivation.

Unit 2. Single reactor system (8)

Constant volume and variable reactors, batch operation of a well mixed enzyme and cell culture reactor, fed batch operation of a well mixed enzyme and cell culture reactor, continuous operation of well mixed enzyme and cell culture reactor, continuous operation of plug flow enzyme and cell culture reactor, autocatalytic reactions, recycle reactors-plug flow reactor and continuous stirred tank reactor, comparison between major modes of reactor operation.

Unit 3 Multiple reactor system (6)

Continuous stirred tank reactors of equal size in series, continuous stirred tank reactors of unequal size in series, finding conversion in given system, determining the best system for a given conversion, plug flow reactors in series and parallel, reactors of different types in series.

Section-II

Unit 4 Multiple reactions **(**

Simple reactions ,stepwise reactions, parallel reactions ,series reactions, maximising r in batch reactor , plug flow reactor and continuous stirred tank reactor, reactor choice for series reactions and series parallel reactions, reversible reactions.

Unit 5 Design for multiple reactions (8)

reactions in parallel- qualitative discussion about product distribution, quantitative treatment of product distribution and reactor size, selectivity.

reactions in series-quantitative discussion about product distribution in plug flow and batch reactor.

Unit 6 Deviations from ideal reactors (8)

Concept of non ideality, reasons of non ideality, RTD studies, f curve, c curve, e curve, diagnosis of ills of flow reactors, modelling of non ideal behaviour-dispersion model, tanks in series model.

References:

1. Chemical Reaction Engineering: Levenspile O

2. Chemical Engineering Kinetics: Smith J.
3. S.M. Walas, "Reaction Kinetics for Chemical Engineers", McGraw Hill, New York.
4. Elements of Chemical Reaction Engineering: H.Scott, Fogler.
5. J. Rajaram and J.C. Kuriacose, "Kinetics and Mechanics of Chemical Transformations ",
Macmillam India Ltd. , 1993.
6. Basic Biotechnology, edited by Colin Ratledge and Bjorn Kristiansen, Cambridge University Press 2003.
7. Biochemical Engineering Fundamentals, Bailey, and Ollis, McGraw Hill Book Co.1986.
8. Bioreacation Engineering, K. Schergeri, Vols 1 & 2, John Wiley. 1985.
9. Bioprocess computations in Biotechnology, T.K. Ghosh, Ellis Horwood Publications, 1988.
10. Advanced Biochemical Engg., ' Henry R. Bugay Georgs Belforj, John Wiley & Sons.'
11. Process Biotechnology Fundamentals, S.N. Mukhopadhaya, Viva Books Pvt. Ltd., 2001'
12. Bioprocess Engineering Principles by Pauline Doran

List of Experiments:

Minimum eight experiments should be performed. Suggested list is as below

1. Study of first order reaction.
2. Inversion of sucrose.
3. Study of pseudo first order reaction- Acid catalyzed hydrolysis of methyl acetate
4. Study of a second order reaction – Saponification of ethyl acetate.
5. Determination of Arrhenius parameters for amylase or invertase.
6. Study of homogeneous catalytic reaction, decomposition of hydrogen peroxide, acid
catalyzed ester hydrolysis.
7. Batch fermentation of sucrose using invertase.
8. Study of PFR.
9. Study of CSTR.
10. Study of CSTR combination in first order reactions.
11. Study of F & C curves in CSTR.
12. Study of F & C curves in helical coil reactor.
13. Study of PFR & CSTR combination in second order reaction.

2. PROTEIN ENGINEERING

	Hrs		Examination Marks
Lectures	: 4 /week	Theory	: 100
Practical	:	Term Work	: 25

SECTION I

UNIT I

Applied Protein Biotechnology- (3)

Engineering proteins as target molecules- engineering enzymes for stability, specificity, purification, medium engineering, engineering antibodies, engineering signal molecules, industrial enzyme engineering, protein engineering for health care, diagnostics and bioremediation.

UNIT II

Effect and importance of amino acids and conformation of proteins (8)

Protein - general introduction, forces that determine protein structures and elucidation of protein structure. Protein folding *in vivo* and *in vitro*, successful protein folding on an industrial scale. Thermodynamics and kinetics of protein folding, folding and diseased states. Analysis of conformational stability of protein by optical spectroscopy and gel electrophoresis and immunochemical methods.

UNIT III

Peptide mapping (4)

Cleavage of peptide bonds by chemical and enzymatic methods, controlled and complete proteolysis, proteolysis in sodium dodecyl sulphate (SDS) solution, Separation of polypeptide fragments.

UNIT IV

Structure-Function relationship of proteins (8)

Conformation of specific proteins with respect to their active site - subtilisin, ribonuclease. Protein structure and molecular approach to medicine; introduction to sickle cell anaemia, viruses and their impact on health as seen through structure and function, HIV and AIDS, p^{53} and its role in cancer.

SECTION II

UNIT V

Basic concept of designing a new protein / enzyme molecule (8)

Site directed mutagenesis, PCR method and Non rational design –DNA Shuffling, Directed molecular evolution, Error prone PCR, RACHITT, ITCHY, Solid Phase Peptide Synthesis (Epitope synthesis) Chemical synthesis of proteins, Protein Semisynthesis.

UNIT VI

Engineering proteins for enhanced recovery (4)

Engineering proteins for enhanced recovery and folding of recombinant proteins using fusion protein strategies for Affinity purification - His tag, Strep tag.

UNIT VII

Solvent engineering, stabilizing industrial enzymes by protein engineering (3)

Examples as lipases and Subtilisin - application, improvement of activity.

UNIT VIII

Engineering therapeutic proteins and antibodies (4)

Antibodies structure, antibody humanization and characterization. Recombinant antibody expression, Designer antibodies.

UNIT IX

Chemical modification (5)

Chemical modification in the homologous and heterologous proteins produced from prokaryotes: Phosphorylation, glycosylation, methylation, formylation, methioniation and demethionation (examples like- rat glutathione S-tranferase, *Hafina alvei* etc.).

REFERENCES:

1. Klaus Demobowsky, Novel Therapeutic Proteins: Wiley Publications.
2. Messer- Schmidt, Handbook of Metalloproteins – 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. G, Protein Biotechnology and Biochemistry, 2nd ed., Wiley Publications
6. Westermeier – Proteomics in Practice- Wiley Publications.
7. Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
8. Jeffrey L. Cleland *et al*, Protein Engineering Practices and Principles, Wiley Publications.
9. Protein Structure, a practical approach, 2nd edition, edited by T.E. Creighton, Oxford university press.
10. Protein Function, a practical approach, 2nd edition, edited by T.E. Creighton, Oxford university press.
11. Biotechnology, second, completely revised edition, edited by H.J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler, Volume editors A. Mountain, U. M. Ney, D. Schomburg, Volume 5a, Willey VCH.

3. PHARMACEUTICAL BIOTECHNOLOGY

	Hrs		
		Examination Marks	
Lectures	4	Theory	: 100
Practicals		Term Wokr	: 25

SECTION I

Unit I **10**

Introduction, classification, biosynthesis, production and mechanism of action of pharmaceutical products : β-lactams, streptomycin, cephamycin, lincomycin , anticancer agents , peptide antibiotics, tetracycline, hybrid antibiotics.

Unit II **8**

Drug targets classification: DNA, RNA, post-translational processing enzymes, metabolic , enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane)proteins, ligand-gated ion channels (Oligomeric transmembrane proteins), transporters (multi-transmembrane proteins).

Unit III **6**

Drug manufacturing: Liquid dosage forms – solutions, suspensions and emulsions; Topical applications – ointments, creams, suppositories; Solid dosage forms – powders, granules, capsules, tablets, coating of tablets: Aerosols; preservation; packing techniques.

SECTION II

Unit I **5**

Biopharmaceuticals: Introduction, the status of the industry, the problems of biopharmaceuticals: differences from new chemical entities(NCE), biopharmaceuticals will be expensive to manufacture ,biopharmaceuticals cannot be given orally and will have wrong pharmacokinetics, biopharmaceuticals cannot be subject to normal preclinical and clinical testing, biopharmaceuticals are not patentable, the regulatory authorities will not know how to deal with biopharmaceuticals, biopharmaceuticals will not be accepted by physicians and their patients.

Unit II **6**

Biopharmaceutical Product Development: Case Study: D2E7 : Development of a human antibody to tumor necrosis factor(TNF), expression system, bioreactor, clarification, capture, and fine purification, product characterization, drug product formulation, progress toward a commercially viable process, cell line and bioreactor improvements, transgenic expression system, high –capacity purification technologies.

Unit III **6**

Hepatitis vaccine, insulin, growth hormone production using r- DNA technology.

Unit IV **4**

Oligonucleotides: Gene therapy in HIV infection, antisense therapy, ribozymes.

Unit V **3**

Pharmacological screening and assays: General principles of screening; correlations between various animal models and human situations.

Text/Reference books:

1. Understanding Biopharmaceuticals: Manufacturing and Regulatory Grindley, Jill E. Ogden
2. Murray Moo-Young- Comprehensive Biotechnology Vol.3.2004 (Permagon Press)
3. A.H. Scrage, 'Biotechnology for Engineers, 1988.
4. Christine M. Bladon. John Wiley & Sons, Ltd.(2002). Pharmaceutical Chemistry
5. A multi volume comprehensive treatise, Biotechnology second, completely revised edition, edited by H. J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler Volume 5a.
6. Grietje Molema and Dirk K.F.Meijer. Wiley-VCH. (2002). Drug Targeting Organ-Specific strategies.
7. W.B. Pratt and P. Taylor, Churchill Livingston "Principles of Drug Action".
8. A.M Hillery, A. W. Lloyd and J. Swarbrick, Harwood Academic Publisher. "Drug Delivery and Targeting".
9. Murray Moo-Young -Comprehensive biotechnology Vol.3.2004 (Permagon Press)
10. Lachman, L. et al., the Theory and Practice of Industrial Pharmacy, 3rd Edition, Varghese Publishing House, 1987.
11. Pharmaceutical microbiology edited by W.B. Hugo and Russel, 6th edition, Blackwell Scientific publication.
12. Ansel, H.C. et al , Pharmaceutical Dosage Forms and Drug Delivery Systems, 7th Edition, Lippincott Williams, Wilkins, 2002.
13. Handbook of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, Haworth Press.Inc. First edition 2004.

4. Bioprocesses

Hrs	Examination Marks
Lectures 4	Theory : 100
Practicals 2	OE : 25
	Term Work : 25

SECTION I

Unit 1. **(5)**

Fermentative production of Organic solvents:-Ethanol, Acetone, Butanol- (History, microorganisms, biosynthetic pathway, example of one media, fermentation method, recovery, commercial products available.)

Unit 2. **(5)**

Alcoholic beverages: Beer, Wine-Red, White and Sparkling, Whisky- (History, microorganisms , biosynthetic pathway, example of one media, fermentation method, recovery, commercial products available)

Unit 3. **(5)**

Fermentative production of Organic acid: --Lactic acid, Citric acid, Acetic acid, Propionic and Butyric acid – (History, microorganisms ,biosynthetic pathway, example of one media, fermentation method, recovery, commercial products available.)

Unit 4 **(4)**

Production of Enzymes:- Lipases, α–Amylases, Glucose isomerases, L-Asparginase, Immobilization of enzymes & cells.

Unit 5 **(3)**

Concepts of Biofilters, Biopulping.

Unit 6 **(2)**

Biological Production of Hydrogen-Biofuel cell.

SECTION II

UNIT 7 **(4)**

Fermentative production of Vitamins: Vitamin B12, riboflavin, β – carotene – (History, organisms, biosynthetic pathway, example of one media, fermentation method, recovery, commercial products available). List of all vitamins & list of diseases produced by their deficiency

UNIT 8 **(5)**

Fermentative production of Amino Acid:- L-glutamic acid, L-Phenylalanine, L-lysine, L- tryptophan- (History, organisms, biosynthetic pathway, example of one media, fermentation method, recovery, commercial products available.)

UNIT 9. **(3)**

Production of Single cell protein from alkane, methanol, municipal sewage. Production of oil and baker's yeast

UNIT 10 Biotransformation **(4)**

Steroid transformation & aromatic pesticide transformation (Types of reactions, at least one example of each type, organisms involved, processes of fermentation etc.)

UNIT11. **(2)**

Production of Biosurfactants; – Xanthan & Dextran

UNIT12. **(4)**

Bioenergy

a) Biodiesel production from various feedstocks.

b) Biogas production from municipal sewage (digester types, chemical reactions in methane production, organisms involved, composition of biogas)

UNIT13. **(2)**

Production of pigments: Anthocyanin, Flavins

List of Practicals (Any 8)

1. Production of lipase
2. Estimation of lipase
3. Estimation of glucose by Anthrone method.
4. Viability testing of fermenting organisms
5. Estimation of Citric acid by pyridine and acetic anhydride method
6. Production of Xanthan gum
7. Production of Baker's yeast
8. Primary screening of antibiotic producer from soil
9. Primary screening of acid producer from soil
10. Identification of amino acid over producer
11. Screening of pigment producing microorganisms
12. Biotransformation of chitin to chitosan

Note- external orals should based on practicals conducted

Textbooks/ References:

1. M.M. Young, "Comprehensive Biotechnology", Vol 3. and 4 Pergamon Press, Oxford, 1985.
2. Alan R. Liss, "Advances in Biotechnological Processes," Vol.6, Page 1.30, 1986.
3. D.A. Shapton and R.G Board, 'Safety in Microbiology,' Academic Press, London, 1972.
4. H.D. Kumar, "Modern Concepts of Biotechnology", Vikas Publishing house Pvt. Ltd., 1998.
5. Keshav Trehan, " Biotechnology", New Age International (P) Ltd., 2002,
6. S.N. Mukhopadhyay I. Campbell, F.G. Priest, Process Biotechnology Fundamentals, Viva Books Ltd., 2001
7. C.M. Brown, Introduction to Biotechnology, Panima Publishing Corporation, 2002.
8. A textbook of Industrial microbiology (second edition)Wulf Crueger & Anneliese Cruger 2000Panima Publishing Corporation
9. Industrial microbiology by Prescott/Dunn agrobios (India)
10. Introductory practical microbiology -by Jayababu Mudili
11. Practical Biochemistry by David Plummer.

5. Elective-I
PLANT BIOTECHNOLOGY

	Hrs	Examination Marks	
Lectures	4 /week	Theory	: 100
Practical	--	Practical	:
		External	:
		Internal	:

SECTION-I

UNIT I TISSUE CULTURE **(7)**

Introduction to cell and tissue culture; Tissue culture media (composition, preparation); Plant growth regulators and elicitors, Initiation and maintenance of callus and cell suspension culture, Micropropagation, Virus -free plants, Embryo culture and embryo rescue, Organogenesis and somatic embryogenesis; Protoplast isolation culture and fusion; Hairy root cultures and their cultivation

UNIT II TISSUE CULTURE APPLICATIONS I **(4)**

Production of haploids and homozygous line (Anther, pollen and ovary culture), Somaclonal variations, DNA Banks and Germplasm conservation (Cryopreservation);

UNIT III TISSUE CULTURE APPLICATIONS II **(5)**

Production of secondary metabolites from plant cell cultures; Processes for enhancing the production of secondary metabolites. Technology of plant cell culture for production of chemicals; Bioreactors systems and models for mass cultivation of plant cells, kinetics of growth and product formation.

UNIT IV PLANT TRANSFORMATION TECHNOLOGY **(9)**

Agrobacterium mediated gene transfer; *Agrobacterium* based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment and other methods. Transformation of monocots, Transgene stability and gene silencing. Impoartant considerations (Use of 35S and other promoters, Genetic markers, Reporter gene with introns, Use of scaffold attachment region, Multiple gene transfer)

SECTION-II

UNIT V PLANT GENETIC ENGINEERING FOR PRODUCTIVITY AND PERFORMANCE I (BIOTIC STRESS) **(4)**

Herbicide resistance, Insect resistance, Disease resistance, Virus resistance.

UNIT VI PLANT GENETIC ENGINEERING FOR PRODUCTIVITY AND PERFORMANCE II (ABIOTIC STRESS) (4)

Abiotic stress tolerance; Drought, Temperature, Salt, Post harvest losses, Long shelf life of fruits and flowers, Male sterile lines, Transgenic plants as Bio-factories.

UNIT VII MOLECULAR FARMING & INDUSTRIAL PRODUCTS (4)

Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Antigens (edible vaccine) and plantibodies.

UNIT VIII METABOLIC ENGINEERING (3)

Metabolic Engineering for Plant Secondary Metabolites.

UNIT IX MOLECULAR MARKER AIDED BREEDING (6)

Molecular markers,. markers based on hybridization(RFLP Maps),Markers based on PCR amplifications(RAPD Markers,STSs,Microsatellites,SCARs,SSCP,AFLP),Molecular Marker Assisted Selection: molecular breeding, Linkage analysis, Map-based cloning, QTL(Quantitative Trait Loci)

UNIT- X (3)

Arid and Semiarid Plant Biotechnology, Green House and Green Home Technology

TEXT BOOKS/ REFERENCES:-

1. Roberta Smith, Plant Tissue Culture: Techniques and Experiments. 2nd ed.,Academic Press, 2000.
2. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. 2004
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press; 2nd ed, 2000.
4. Crispeels, M.J. and Sadava, D.E., Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers (2nd Edition), 2003.
5. Bhowjwani, S.S., Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier, 1990.
6. Charles Cunningham and Andrew J.R. Porter, Recombinant Proteins from Plants: Production and Isolation of Clinically Useful Compounds (Methods in Biotechnology), Humana Press, 1997.
7. Bernard R. Glick and John E. Thompson, Methods in Plant Molecular Biology and Biotechnology, CRC Press, 1993.
8. I. Potrykus and G. Spangenberg, , Gene Transfer to Plants (Springer Lab Manual), Springer Verlag, 1997.
9. Peter M. Gresshoff, Plant Genome Analysis: Current Topics in Plant Molecular Biology. CRC Press, 1994.
10. John Hammond, Peter McGarvey, Vidadi Yusibov, Plant Biotechnology: New Products and Applications, Springer Verlag, 1999.
11. Introduction to Plant Biotechnology, Second Edition, by H.S. Chawla

5. Elective-I
BIOMEDICAL ENGINEERING

	Hrs	Examination Marks	
Lectures	4 /week	Theory	: 100
Practical	--	Practical	:
		External	:
		Internal	:

Section I

UNIT-I Biomedical Engineering (2)

1.1 General Introduction to Biomedical Engineering.
1.2 Applications of Engineering in Medicine
1.3 Biomedical applications including drug delivery, tissue regeneration.
1.4 Ethical consideration in Medical Research

UNIT-2: Electrical Potentials in the human body (6)

2.1 Neuromuscular system: neurons, synapses and muscles
2.2 Electrical properties of nerves and muscles,
2.3 Problems of Neuromuscular system and diagnostics

Unit-3: Cardiovascular System: (6)

3.1 Anatomy & physiology of heart
3.2 cardiac cycle and ECG, problems and solutions to electrical potentials in the heart
3.3 Blood and vascular modeling,
3.4 Haemodynamics,
3.5 Vascular disease and vascular disease management,

Unit-4: Skeletal System and Prosthetics (4)

4.1 Introduction to skeletal system
4.2 Prosthetics

Section II

UNIT-5: Excretory system and Dialysis: (6)

5.1 Renal anatomy & Physiology
5.2 Types of dialysis
5.3 Dialysis machines & mass transport.

UNIT-6 Biomaterials (4)

6.1 Types of Biomaterials and surface modifications.
6.2 Testing of Biomaterials *in vitro* and *in vivo.*
6.3 Implantable sensors

UNIT-7 Medical Imagining:

7.1 X-rays, design considerations of X-ray tubes, medical Image processing – projections
7.2 3D-2D, slice identification, CAT, NMR, MRI, PET / SPECT.

UNIT-8: Cellular engineering and Tissue Engineering (4)

8.1 Cellular Engineering applications
8.2 Tissue Engineering applications

Text / References:

1. J.T. Bushberg, J.A. Scibert, E.M. Leidholdt (Jr), J.M.Boone: The Essentials Physics of medical Imaging, Lippincott Williams and Wilkins, USA, 2002.

2. R.B. Buxton: Introduction to Functional Magnetic Resonance Imagining: Principals & Techniques, Cambridge Univ, Press, UK, 2002.

3. J. Enderle, S. Blanchard & J. Bronzino (Eds): Introduction to Biomedicaql Engineering, Academic Press 2000.

4. John G. Webster (Ed): Medical Instrumentation – Application and Design, 3rd Ed. John Wiley & Sons, 1989.

5. J.B.West.(Ed) Best and Taylor's Physiological Basis of Medical Practice, 11th Ed., Williams and Wilkins, Baltimore 1985.

6. Y.C. Fung: Biomechanics, Springer – Verlag, New York, 1981.

7. S.Oka: Cardiovascular Haemorheology, Cambridge University Press 1981.

5. Elective-I
GOOD MANUFACTURING PRACTICES

	Hrs	Examination Marks	
Lectures	4 /week	Theory	: 100
Practical	--	Practical	:
		External	:
		Internal	:

Section I

UNIT 1: An Introduction to Pharmaceutical GMP (6)

Good Manufacturing Practices- Introduction, WHO guidelines on GMP for Pharmaceutical Products, History of Good Laboratory Practices, Quality Assurance in Good Laboratory Practices.

UNIT 2: Quality Standards and Quality Assurance in Pharmaceutical Industries (6)

Quality standards- Advantages and Disadvantages, Concept of Quality Control and Quality Assurance- there functions and advantages, Quality Assurance and Quality Management in Pharma Industry, Customer requirement of Quality.

UNIT 3: Pharmaceutical Validation (7)

Types of Validation, Scope and Importance of Validation, Limitations of Validation, Organization of Validation, Elements of Validation (Q, OQ, PQ and DQ), Cleaning Validation, Validation of Analytical procedures as per ICH guidelines.

UNIT 4: IPR and Pharmaceutical industry (3)

Section II

UNIT 1: Good Manufacturing Practice in Food industries (7)

Implications of cGMP and food plant sanitation. The regulation for cGMPs. Planning of plant sanitation program and construction factors. Hygienic design of food plants and equipments. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection: Physical, chemical and microbiological approach.

UNIT 2: Quality control **(4)**

Introduction to Quality control and total Quality control in the food Industry. Various Quality attributes of food such as size, shape, texture, color, viscosity and flavor. Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Food regulation and compliance. Food inspection and Food Law.

UNIT 3: Critical Control Points in Food Industries **(3)**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system (Critical quality control points in different stages of production including raw materials and processing materials).

UNIT 4: Government and Trade Standards of Quality **(8)**

Federal Food and Drug law, FDA action, BSTI laws, BSTI action and activities and other Food Laws (legalization) and trade and company standard, Control by (National, International, Social organizations, e.g., FAO, WHO, UNICEF, CAB, Society, e.g. NSB, Professional societies).

References:

1. Quality Control of Herbal Drugs- Dr. Pulok A Mukherjee (Business Horizons Pharmaceutical Publishers)
2. cGMP for Pharmaceuticals – Manohar A Potdar (Pharma Med Press)
3. Validation of Active Pharmaceutical Ingredients-Ira R Berry (CRC Press)
4. Guidelines on c GMP and Quality of Pharmaceutical Products- S.Iyer (DK Publication)
5. Quality Assurance and Quality Management in Pharmaceutical Industry- Y.Anjaneyulu (Pharma Book Syndicate)
6. Quality assurance in Analytical Chemistry, B. W. Wenclawiak., M. Koch. E. Hadjicostas, Springer.

5. Elective-I
ENVIRONMENTAL BIOTECHNOLOGY

	Hrs	Examination Marks	
Lectures	4 /week	Theory	: 100
Practical	--	Practical	:
		External	:
		Internal	:

SECTION I

UNIT I ENVIRONMENTAL POLLUTION (5)

Water, air, noise and radiation (introduction, source and effects of pollutions): Types of waste, properties, global warming.

UNIT II METHANOGENESIS (3)

Methanogenesis-Methanogenic, acetogenic and fermentative bacterial processes and conditions.

UNIT III MICROBIAL BIODIVERSITY (5) Microbial diversity on earth: - extent and importance, recovery problem. Finding New diversity, biodiversity of bacteria: level of bacterial diversity, isolation strategies. Fungal biodiversity: - isolation and identification. Recovering biodiversity using environmental DNA, accessing uncultured microbes. Environmental genomics: Screening environmental libraries, barriers and challenges.

UNIT IV TREATMENT OF INDUSTRIAL WASTES (6)

Waste water characteristics; biological waste treatment; kinetic models, unit operations, design, principle and modeling of activated sludge process. Trickling filters, fluidized reactor, up flow anaerobic sludge blanket reactor, contact process, packed bed reactor, hybrid reactors, sequential batch reactors; Bioconversions of agricultural and organic waste material into gainfully utilizable products- cellular hydrogen, food and feed stocks.

UNIT V ENVIRONMENTAL SAFETY REGULATIONS (4)

Environment Protection Act- Air, Water and Forest Conservation.
Environmental Ethics- Issues and Possible solutions.

SECTION II

UNIT I BIOREMEDIATION (6)

Biodegradibility: Petroleum hydrocarbons, Halocarbons, chlorophenols, nitro aromatics.Applicability of bioremediation-Intrinsic bioremediation, biostimulation, bioaugmentation (Molecular breeding, GEMs, adhesion deficient microorganisms), application of Bioremediation to various sites and aquifers, marine oil spills, Metal contaminated soil.

UNIT II BIOPROSPECTING (5)

Introduction, Sampling, Sample preparation(physical dispersion, chemical dispersion),Cell extraction: Immunomagnetic capture(Selective cell capture, nonselective cell recovery),Recovery of cells, capture of genes from environmental samples ,screening for specific genes Vs Environmental library construction, DNA extraction from environmental samples. Detection of functional activity

in environmental samples: metabolic analysis of environmental samples (Biolog),Sample enzyme activity, bioprospecting for specific enzymes.

UNIT III BIOLOGICAL CONTROL (5)

Biological control of foliar pathogens and pests with bacterial biocontrol agents: biocontrol agents, ecology of the plant pathogen or pest, source of antagonist, Empirical approaches to select biocontrol agents.

UNIT IV BIOMARKERS AND BIOREPORTERS (5)

Use of biomarkers and bioreporters to track microbes and monitor their Gene Expression: Biomarker Genes: Antibiotic résistance, Heavy metal resistance, Ice nucleation, Chromogenic substrate cleavage enzyme, bioluminescence, GFP, Combination of biomarker genes. Bioreporter Genes: biomarker genes as bioreporter genes, practical considerations of Biomarkers and Bioreporters.

UNIT V DELIBERATE RELEASE OF RECOMBINANT MICROORGANISMS IN THE ENVIRONMENT (4)

Isolation of bacteria for modification and field release, Genetic modification of candidate bacteria suitable for field release, microcosm evaluation and field studies, assessing efficacy, autecology and impact.

Textbooks /References:

1. Manual of Industrial Microbiology and Biotechnology, II Ed., ASM Press Washington, Arnold Demain and Julian Davies (2004)
2. J. Winter, Environmental Processes I-III 2nd Ed., Wiley Publications. Metcalf Eddy - Waste water Biotechnology.
3. Ted Munn, Encyclopaedia of Global Environmental Changes, 5 Vol. Set Wiley Publications.
4. Metcalf Eddy – Waste water Engineering – 3rd Ed., THM publications.
5. R.S. Ramalho, - Introduction to Waste Water treatment.

5. Elective-I
GENOMICS AND PROTEOMICS

	Hrs /week	Examination Marks	
Lectures	4	Theory	: 100
Practicals		Practical	:
		External	:
		Internal	:

SECTION I

UNIT I

ORGANIZATION OF THE PROKARYOTIC AND EUKARYOTIC GENOMES (7)

Definition of Gene, Genome, and Genomics, Introduction to genome databases; Genome maps and types; current sequencing technologies; partial sequencing; approach to gene identification; gene prediction methods and software; Annotation of genome. REBASE, Genome diversity; Taxonomy and significance of genomes-bacteria, Yeast, *Caenorhabditis*, *Arabidopsis sp.*, etc.

UNIT II

HUMAN GENOME (7)

Introduction, Mapping of Human Genome; Construction of physical maps; Basics of radiation hybrid maps; sequencing of the entire genome, annotation and analysis of genome sequences; sequence repeats, transposable elements, gene structure, pseudogenes; gene analysis; gene order; chromosome rearrangement; compositional analysis; clustering of genes; composite genes; Implications of the Human Genome Project; Single Nucleotide Polymorphism (SNPs), detection and its implications.

UNIT III

DNA MICROARRAY (6)

Introduction, steps for gene expression, concept of microarrays, methods for gene expression; DNA array for global expression profile; types of DNA array, array databases; tools for microarray analysis; soft-finder, xCluster, MADAM, SAGE, microarray design, microarray experimentation, fabrication computational analysis of microarray data, applications of DNA microarray.

SECTION II

UNIT IV:

PROTEIN AND PROTEOME ANALYSIS

(5)

Protein, protein sequence information, physicochemical properties based on sequence, Introduction to sequence alignment; local sequence alignment and global sequence alignment, gaps, insertion of gap penalties, extension gap penalty, scoring matrices, PAM, BLOSUM, useful programs.

UNIT V:

PROTEIN MICROARRAY

(8)

Introduction, proteome, proteomics, protein separation techniques; 2D Gel electrophoresis, liquid chromatography, affinity chromatography (for cell map proteomics); proteome analysis; mass spectroscopy and its uses in protein identification; MALDI-TOF-TOF, electro spray ionization(ESI), tandem mass spectroscopy (MS/MS), analysis, tryptic digestion and fingerprinting (PMF), expression proteomics (express profile); profiling and diagnostics, drug target discoveries.

UNIT VI:

PROTEIN –PROTEIN INTERACTIONS **(7)**

Introduction, yeast two-hybrid, high throughput techniques for yeast two-hybrid protein interactions, computationally directed two hybrid screen, Phage display, computational detection of functional linkages between proteins; phylogenetic profile, domain fusion, gene neighbourhood, gene cluster, analysis of genome wide protein-protein interactions in yeast, genome wide yeast two hybrid analysis of other organisms, protein fragment complementation assay.

Textbooks/References:

1. Princ**i**ples of **G**enome Analysis and Genomics-3rd edition 2003, S. B. Primerose and R.M.Twyman, Blackwell publishing company Oxford, UK.

2. Bioinformatics; A Practical guide to the analysis of Genes and Proteins.; Edited by Andreas D. Baxevanis and Francis Ouellette.

3. Bioinformatics sequence and genome analysis.2nd edition, 2004, David Mount, Cold Spring Harbor Laboratory Press New York.

4. Introduction to proteomics tools for New Biology, 1st edition, D.C. Leibler, Humana Press, Inc., New Jersey, USA.

5. www.ncbi.nlm.nih.gov

6. COMPREHENSIVE TESTS

	Hrs	Examination Marks	
Lectures	---	Theory	:
Practical	2/week	Term Work	: 50

Syllabus of S.E.-I to B.E.-I Biotechnology Engineering.

1. Objective type question based tests are to be conducted.
2. Every week 2 hr tests for 50 marks are to be conducted.
3. Schedule of comprehensive test should be displayed at the start of the semester.
4. Subjects from SE (Sem III) to BE (Sem VII) should be considered for above tests.
5. Related subjects should be merged on the basis of principle fields i.e. Microbiology, Biotechnology, Biochemistry, Biochemical Engineering, Mathematics etc.
6. Ten tests should be conducted in the Semester and average of best eight tests should be considered for final marks.

7. INDUSTRIAL TRAINING
(At the end of VI Semester)

	Hrs	Examination Marks
Lectures	---	Theory :
Practical	---	Term Work : 50

The concern student should complete the 4 week training at the end of the 6th semester. In these four weeks, they have to work in the industries as a trainee and submit brief report. The internal marks shall be given on (1) Type of work carried in the industries (2) Reports (3) Orals and/ or (4) Written examination.

Report shall consist of:

1. History
2. Raw material
3. Process flow chart
4. Equipment details
5. Production process details
6. Pollution control aspects
7. Quality control aspects
8. Cost of Production and profits
9. Suggestions for improvement
10. Safety Aspects.

8. PROJECT WORK

	Hrs	Examination Marks	
Lectures	---	Theory	:
Practical	4/week	OE	: 25
		Term Work	: 25

The following initial work regarding the project in the first semester to be carried out.

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

1. Processes based Project: Manufacture of product.

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.

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 copy in duplicate.

Department should see that the assessment procedure should be the same for all the students of the class. The Project Work consists of collection of literature, study of the various process selection of the process, computation of material and energy balances, process design of important please of equipment, 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 conclusion 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 3 students, For term-work (Internal) 25 marks, the assessment should be by conducting frequent written tests, seminars during the year and oral exam, at the end of the year conducted by all the staff members of the dept.

For external 25 marks, the project work should be assessed by an oral exam to be held by at least two examiners, one internal and one must be external invited from other university or industry at the end of the year.

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

Suggested fields for project work

1. Fermentation based
   Microbial fermentation, Animal cell fermentation, Plant cell fermentation
   Combitorial chemistry: Enzymatic processes

2. Microbial/enzymatic treatment of domestic and industrial waste water treatment.

3. Modeling and Simulation: Microbial fermentation, Waste water treatment, modeling genetic regulation (genetic switches, signal transduction, mixed cascadic systems), Insilico microorganisms (metabolic flux analysis, elementary mode analysis of metabolic fluxes), Insilico mammalian/animal organs, Vertual patients (analysis by top to bottom and bottom top analysis)

4. Bioinformatics: Sequence homology, clustering of genes, parametric analysis for homology and catalytic activity of enzyme, microarray data analysis.

5. Immunological studies: Modeling and experimental verification of antigenantibody interactions (steady state and dynamic modeling).

6. Metabolic Engineering and Genetic Engg. (modeling and experimental aspects of metabolic flux analysis for inhibitor development and planning for genetic mutation/deletion/strain improvement)

7. Toxicological studies: Effect of synthetic and plant extracted active compounds on eukaryotic organisms (Yeast and animal cells).

8. Extraction and purification techniques: Solvent/supercritical extraction of biologically active compounds from plants and herbs, Chromatographic purification.

9. Nutritional analysis of local food components and linear programming for balance diet design for Kolhapur region.

10. Techniques development for the preservation of farmer's products (fruits and vegetables) and scale-up of exiting techniques such as ozonation , γ-rays preservation; Optimization of long term preservation of milk by supercritical carbon dioxide.

11. Food industry: Optimization/Modification of microbial processes of food industry, nutritional enrichment of food products.

12. Production of Bioinsecticides and pesticides

13. Insect cell differentiation and development.

14. Tran differentiation of stem cells.

15. Reproductive biotechnology: Artificial reproductive technology.

16. Trace proteins studies.

17. Biotransformation.

18. Tracer techniques for establishment of metabolic pathways.

19. Microbial desalting of sea water.

20. Microbial leaching of metals from ores.

21. Linear programming for dose design.

22. Environmental Biotechnology: Hospital waste treatment

23. Leather tanning by natural products (Amba tannin).

Shivaji University, Kolhapur

B.E. Part – II (Biotechnology Engineering) SEM.VIII

1. BIOSEPARATION PROCESSES

Lectures	: 4 Hrs/Week	Examination Marks:	
Practicals	: 2 Hrs	Theory	: 100
		POE	: 50
		Term Work	: 25

SECTION I

UNIT I **(2)**

Introduction, different sectors in Biotechnology, characterization of biomolecules and bioprocesses, characterization of fermentation broth, recovery in modern versus classical biotechnology.

UNIT II **(10)**

Removal of insolubles

Filtration – Introduction, types of filtration equipments, filter media and aids. Basic theory of filtration, filtration equation for constant – pressure filtration , filtration equation for constant rate filtration, continuous filtration Vs batch filtration, cross flow Vs dead end filtration, comparison of cross flow with other competing technologies, operating configurations, applications.

Centrifugation – Introduction, forces developed in centrifugal separation, Equations for rates of settling in centrifuges, sedimentation centrifuges, filtering centrifuges, Filtering centrifuges vs Sedimentation centrifuges, types of centrifuges.

Cell Disruption- Different types of Cell walls, mechanical, physical, enzymatic, chemical methods of disruptions, Kinetics and analysis of disruption**.**

UNIT III **(5)**

Extraction – Introduction, Solvent extraction principles, extraction process, types of extraction equipment and selection, operating modes of extraction, Aqueous two phase extraction, Theoretical principles of aqueous two phase extraction, Super critical fluid extraction, Applications- Extraction of bitter flavor, Decaffeination of coffee.

UNIT-IV **(5)**

Adsorption – Chemistry of adsorption, adsorbents, adsorption isotherms- Linear, Freundlich, Langmuir Isotherms. Affinity adsorption, Ion exchange adsorption. Batch adsorption, adsorption in continuous stirred tank, adsorption in fixed beds

SECTION II

UNIT I

Product Isolation **(8)**

Precipitation – Precipitation by salts, organic solvents, isoelectric precipitation, precipitation by electrolytes and non ionic polymers.

Membrane Separation - Classification of membranes processes, factors affecting processes, structure and preparation of membrane, equipment, microfiltration, ultra filtration, reverse osmosis, dialysis, electro dialysis. application of membrane separation processes**.**

UNIT II: **(8)**

Product purification Chromatographic Techniques

Principles of Chromatography – Classification of Chromatographic methods. column chromatography - separation based on mechanism - ion-exchange chromatography, adsorption chromatography , gel-filtration chromatography, hydrophobic interaction chromatography , affinity chromatography, gas liquid chromatography, high performance liquid chromatography, , high performance thin layer chromatography**.**

UNIT III: **(3)**

Electrophoresis: Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-field gel electrophoresis; gel matrices: polyacrylamide, agarose etc.critical parameters for optimum separation and resolution, two dimensional electrophoresis, isoelectric focusing, isotachophoresis**.**

UNIT IV-

Finishing Operations **(3)**

Crystallization- Introduction, theory of crystallization, crystallization equipment, special consideration for fermentation processes, methods of calculation and troubleshooting; drying: freeze drying, formulation.

List of Practicals: (Any 8 experiments)

1. Cell Disruption
2. Ultra filtration
3. Reverse Osmosis
4. Batch Adsorption
5. Extraction
6. Gel filtration
7. Ion exchange Chromatography
8. Vacuum Evaporation
9. Leaf Filter
10. Electrophoresis

Textbooks/ References:

1. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
2. Wilson and Golding, A Biologist's Guide to Principles & Techniques of practical Biochemistry, Cambridge University Press
3. Practical Biochemistry, Principles & Techniques, Keith Wilson and John Walker
4. Protein Purification, M.R. Lodisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical Society
5. Bioseparations, P.A.Belter, E.L.Cussler, Wei-Shou Hu Wiley Publication
6. Bioseparation, B. Shivshanker , Prentice Hall of India Pvt. Ltd. New Delhi
7. Protein Purification- Principles and Practice, Robert. K. Scopes, Springer - Verlag New York Inc.
8. Transport Processes and separation process principles. Christie John Geankoplis, Prentice Hall of India Pvt. Ltd. New Delhi.
9. Unit Operation of Chemical Engineering. Warren L. McCabe smith, McGraw- Hill international edition.
10. Fermentation and Biochemical Engineering Hand book. Principles Process design and equipment, Henry C. Vogal, Celeste L. Todaro, Noyes Publication- Westwood, new Jersey U.S.A.

2. BIOPROCESS MODELING AND SIMULATION

	Hrs			
Lectures	4/week	Examination		Marks
Practicals	2/week	Theory	:	100
		Term work	:	25

Section –I

UNIT-I

Introduction to Modeling: (8)

Introduction, definition of Modeling and simulation, different types of models- Unstructured and structured models, Deterministic and stochastic models, Segregated and unsegregated models, Compartmental models (two and three), genetically structured models.

UNIT-II

Fundamental laws: (8)

Continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics, Model building , application of mathematical modeling, scope of coverage.

UNIT-III

Analysis and optimization of process (8)

Model adaption and checking, preparing the data, parameter determination, model checking, simplification, validation, calibration, optimization of models, analytical methods, and numerical methods.

Section –II

UNIT-I

Heat and mass transfer equipments - (6)

a) Heat exchanger

b) Distillation-continuous binary distillation, multi component steam distillation

c) Liquid liquid extraction-single batch extraction, continuous equilibrium stage extraction, multistage

counter current extraction cascade.

UNIT-II

Reaction equipments - (6)

Batch reactor, semi batch reactor, CSTR, PFR, packed bed reactor, fluidised bed reactor.

UNIT-III

Examples of Mathematical Models: (12)

a) Modeling of fermentations
b) Modeling for activated sludge process
c) Model for anaerobic digestion
d) Metabolic flux analysis
e) Elementary mode analysis
f) Modeling of gene regulation (Genetic switches)

Practicals

Ten practical to be conducted with the use of mathematical and chemical engineering software's such as Hysys, ChemCAD, MathCAD, MATLAB etc. Development of Programs for numerical methods and process simulation.

Textbooks/References:

1. Luyben W.L. "Process Modelling Simulation and Control for Chemical Engineers" McGrawHill,1988.
2. Davis M.E., "Numerical Methods and modeling for Chemical Engineers", Wiley,New York, 1984.
3. Denn M.M., "Process Modelling" Wiley, New York, 1986.
4. Finalyson B.A., "Nonlinear analysis in Chemical Engineering", McGraw Hill,New York, 1980.
5. Chapra S.C., R.P. Canale, "Numerical Methods for Engineers", Tata-McGrawHill Publications.
6. Franks R.E.G., "Modeling and Simulation in Chemical Engineering", Wiely Instscience, NY
7. John Ingam, Irving J. Dunn., "Chemical Engineering Dynamic Modeling with PC simulation", VCH Publishers.
8. Kayode Coker A., "Chemical Process Design, Analysis and Simulation". Gulf Publishing Company.
9. Himmelblau D., K.B. Bischoff, "Process Analysis and Simulation", John wiely &Sons.
10. Wayne Blackwell, "Chemical Process Design on a Programmable Calculator",McGraw Hill.
11. Wayne Bequette, "Process Dynamic, Modelling, Analysis, Analysis and Simulation." Prentice Hall
12. J.R. Leigh, Modeling and Control of fermentation Processes, Peter Peregrinus, London, 1987
13. G. Francis, Modelling and Simulation
14. A. Haerder and J. A. Roels " Application of simple structured I Bioengineering, and P55 in Advances In Biochemical engineering Vol21, A. Fiechts (ed) Spring –Verlag , Berlin, 1982.

15. J.E. Bail ey and D.F. Ollis, Biochemical Engg Fundamentals, 1986, McGraw Hill Book Company.

16.Harrel C and Ghosh B, Bowden R. “Simulation using promodel” , McGraw Hill , 2004.

17.Jiri E, Prenosil, Elmar Heinzle, John Ingham, Irving J. Dunn, Biological reaction engineering: Dynamic modeling fundamentals with simulation examples, science , London,2003.

18.Fiechter A., Ghosh T.K. ,N.Blakebrough, Advances in biochemical engineering , Springier-Verlag,Berlin,5th edition,2005.

19. Elmar Heinzle,Arno P.Biwer,Charles L.Cooney,Development of sustainable bioprocess:modelling and assessment,wiley Publishers,New York,6th edition, 2007.

3. BIOPROCESS ENGINEERING AND ECONOMICS

Lectures	4hr/week	Examination	Marks
Practicals		Theory	: 100

Section –I

Unit I **(6)**

Process Design Development: design project procedure, design information from literature, process development, process creation, process design, flow diagram, equipment design and specification.

Unit II **(8)**

General design considerations: plant location, plant layout, plant operation and control**,** structural design, storage, materials handling, waste disposal, air pollution abatement, water pollution abatement, solid waste disposal, thermal pollution control, health and safety.

Unit III **(6)**

Flow Sheet Synthesis and Development: general procedure for flow sheet synthesis and development, process information, input output structure, function diagram, operation diagram and process flow sheets**.**

Unit IV **(4)**

Economics involved in selection of materials : Factors Contributing to corrosion, combating, corrosion, properties of materials, economics involved in selection of materials, fabrication of equipment, plant utilities in biotech industries.

Section II

Unit V **(6)**

Interest and Investment costs: Types of interest, nominal and effective interest rate, continuous interest, present worth and discount, annuities, types of annuities.

Unit VI **(5)**

Depreciation: Introduction, meaning of value, types of depreciation, service life, salvage value, present value, methods for determining depreciation.

Unit VII **(7)**

Profitability Analysis: Profitability standards cost of capital, mathematical methods calculating profitability: rate of return on investment, discounted cash flow based on full life performance, net present worth, capitalized cost, payout period, relationships for continuous cash flow and continuous interest of importance for profitability analysis**.**

Unit VIII **(6)**

Cost and Asset accounting: Outline of accounting procedure, basic relationships in accounting, the balance sheet, income statement, maintaining accounting records, cost accounting methods

Textbooks/References:-

1. Plant Design & Economics for Chemical Engineers-M.S.Peters & K.D.Timmerhans, McGraw Hill, 1980.
2. A Guide to chemical Engg. Process Design & Economics" Gael D .Ulrich, John Wiley & Sons 1934.
3. Biochemical Engineering Fundamentals, Bailey & Ollis. McGraw Hill Book Co. 1986.
4. Chemical Engineers Handbook 5th ed R.H. Perry& C.H. Chilton, McGraw-Hill Book Company.
5. Chemical Engineering, Volume 6; Third Edition by Coulson and Richardson, Butterworth Heinemann.

4. ANIMAL BIOTECHNOLOGY

	Hrs			
Lectures	4hr/week	Examination		Marks
Practicals		Theory	:	100
		Term Work	:	25

Section I

UNIT I

Introduction to animal tissue culture: (1)

Historical background, cell, tissue and organ culture: advantages, limitations, and applications, stages in animal cell culture

UNIT II

Design, layout and equipments of ATC laboratory: (3)

Planning, construction, layout, essential equipments, laminar flow hoods, co_2 incubator, microscope, centrifuge, freezer, etc. aseptic techniques, objectives, elements, sterile handling, safety, risk assessment, biohazards

UNIT III

Media: (5)

Types of media (natural and synthetic), physicochemical properties, balanced salt solutions, complete media, serum, serum-free media, advantages of serum-free media, disadvantages of serum,

UNIT IV

Primary cell culture: (5)

Isolation of tissue, steps involved in primary cell culture, cell lines, nomenclature, subculture and propagation, immortalization of cell lines, cell line designations, routine maintenance

UNIT V

Characterization & quantitation techniques for cell line: (5)

Need for characterization, morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, transformation, immortalization, aberrant growth control, tumorigenicity, cell counting, plating efficiency, labeling index, generation time.

UNIT VI

Contamination of the cultures: (2)

Source of contamination, type of microbial contamination, monitoring, eradication of contamination, cross-contamination

UNIT VII

Cytotoxicity: (3)

Cytotoxicity, nature of cytotoxicity assay, viability assay, microtitration assay, transformation assay, *in vitro* limitations, apoptosis, cell transformation and properties.

Section II

UNIT VIII **(4)**

Manipulation of cultured cells and tissues.

Scale up of animal cell culture, cell synchronization, cell transformation and properties.

UNIT IX

Cryopreservation: **(4)**

Need and advantages of cryopreservation, cell banks, transporting cells

UNIT X

Application of animal culture **(4)**

Valuable products from cell culture, cell culture based vaccines, somatic cell fusion and application. Antibody Engineering, large scale purification of pharmaceutical products.

UNIT XI

Transgenic and knock out animals: **(4)**

Methodology: embryonic stem cell method, microinjection method, retroviral vector method applications of transgenic and knock out animals.

UNIT XII

In vitro fertilization and embryo transfer: **(3)**

Composition of ivf media, steps involved in IVF, fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA

UNIT XIII **(4)**

Organ and histotypic culture

Organ culture, embryo culture, histotype culture. three dimensional culture, tissue engineering and its importance. Stem cell culture and its importance.

UNIT XIV

Animal ethics **(2)**

Introduction to animal ethics.

Textbooks / References:

1. Animal Cell Culture by John R.W. Masters Oxford University Press
2. Introduction to Cell and Tissue Culture by Jennie P. Mather and Penelope E. Roberts Plenum Press, New York and London
3. Molecular Biotechnology: Primrose.
4. Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press EACC handbook.
6. Culture of animal cells; a manual of basic techniques, Freshney R. I. (1995) John Wiley and Sons, USA
7. Textbook of biotechnology, 3rd Edition, H. K. Das, Wiley, India.

5. Elective-II
APPLIED GENETIC ENGINEERING

	Hrs	Examination Marks
Lectures	4 /week	Theory : 100

SECTION-I

UNIT I **(8)**

Applications of genetic engineering to medicine and agriculture, genetically engineered biotherapeutics, Genetically modified vaccines and their manufacturing.

Genetically modified organisms: transgenic plants, potential applications to improve production and food quality.

UNIT II **(8)**

DNA marker technology in plants, DNA fingerprinting, Pulse field Gel Electrophoresis, Genetically engineered antibodies, phage display and genetic diseases diagnosis.

UNIT III **(8)**

Design of SiRNA vectors, Gene silencing, oligonuclotide synthesis, Automated DNA Sequencing, Human genome project applications in the other spheres of human genome project emphasized by selected articles.

SECTION-II

UNIT I **(8)**

PCR Technology, multiplex, nested, RT PCR, Real Time, overlap, extension and SOEing.

Applications of the PCR in the mammalian genetic engineering, medicines and agriculture.

UNIT II **(8)**

PCR in gene recombination, Deletion, recombination, addition, and Site-specific mutagenesis.

Human gene therapy, transposons, gene targeting and DNA labeling.

UNIT III **(8)**

PCR in molecular diagnostics, fidelity of DNA polymerases, Gene Disorder, Detection of mutation in neoplastic diseases, SSCP, AFLP, RAPD, RFLP, DGGE.

TEXT/REFERENCE BOOKS:

1) PCR Protocols and applications (1990) Edited by M. A. Innis, D. H. Gelfand, J. J.Sninsky, T. J. White.
2) Genome Analysis – A practical approach (1988) Edited by K.E. Davies selected articles from Nature, Science, Cell etc.
3) Genome III –T. A. Brown University Press Publication (2006)
4) Molecular cloning- Volume II
   Sambrook and Russell,Cold spring Harbour University Press (2002)
5) Old RW and Primrose SB, Principles of gene manipulation, Blackwell Scientific Publications, 1992.
6) Ansubel FM., Brent A, Kingston AE, Moore DO, Current protocols in Molecular Biology, Greene Publishing Associates, NY, 1988.

5.Elective-II

FOOD AND DIARY BIOTECHNOLOGY

	Hrs	Examination Marks
Lectures	4 /week	Theory : 100

SECTION-I

UNIT I Chemistry of food **(3)**

Properties of water, determination of moisture in food.

UNIT II Carbohydrates in food. **(5)**

Sources, classification, types of starch, fructans, mannas, and Galactans. Chitins, hyluronic acid, chondroitin sulfate, pectin, Gums, mucilage's, sea weeds, Polysaccharides. Identification of carbohydrates, properties of carbohydrates.

Changes in food after processing-i) Gelatinization, ii) Browning reaction

UNIT III Proteins in food **(4)**

Sources, different types of proteins, native and denatured properties of proteins.

Determination of proteins and amino acids, gel formation-theories, gelatin, denatured protein gel.

UNIT IV Fats and oils. **(4)**

Sources different types of fats. Physical and chemical properties of different types of fats.

Rancidity and reversion. Oil extraction, bleaching and hydrogenation.

Fat products-butter, oleo oil, lard, margarine.

UNIT V Flavor and aroma of food **(2)**

Taste, odor, aroma, extraction of flavor, synthetic flavoring substances.

UNIT VI Vitamins (fat soluble and water soluble), **Macro minerals** (Calcium, Phosphate), (**5)**

Micro minerals –iron, iodine. Flavonoids-Sources classification, structure properties extraction, functions.

SECTION-II

UNIT VII Meat and meat products **(3)**

Muscles, Collagen, Elastin, Cartilage and Bone, Post marteum changes.

Cured and smoked meats, Changes in meat on cooking canned meat, Structure color and meat tenderness.

UNIT VIII Poultry **(2)**

Egg white proteins, egg yolk, Eggs from Chick, Duck, Emu, etc.,

Composition and Nutritional.

UNIT IX Fish and products. **(3)**

Fish oils, Classification, Extraction and Functions.

UNIT X Dairy and dairy products **(5)**

Analysis of milk-Purity and composition. Milk and Milk Products, Pasteurization, Preparations Butter, Cheese-Composition unripened and ripened cheese processed cheese. Milk Powders.

UNIT XI Cereals, vegetables and fruits. **(6)**

Texture, Processing, Pigment in fruit and vegetables, Browning reaction enzymatic and non Enzymatic, Dough's, baking, batters , staling, prevention of mold

UNIT XII Food standards **(5)**

HACCP and IPR

Reference:

1. Food Technology, Processing and Laboratory Control- F.Aylward.
2. Food Chemistry-Lillian land Meyer.
3. Food Microbiology- Frazier W.C., D.C. West off.
4. Food Science and Food Microbiology-Ed- Cristobal Noe Aguilar and Efren Delgado and Ashok Pandey.
5. Hand book of food processing Technology S.C.Bhatia, Vol-I, II and III.
6. Outlines of Food Technology by Harry W, Von Loesecke.
7. Nutrition Science-B Srilakshmi
8. Integrated Biotechnology Vol-II.
9. Heller, Genetic Engineering of food: Detection of Genetic Modifications wiley, Publications.

10. Lel A. Et.All. Microorganisms & Fermentations N.Y .Chemical, Rehm, Biotechnology Set wiley Publications.
11. Keshav Trehan Biotechnology," New Age International Pvt. Ltd. 2002.
12. Food Processing: Biotechnology Applications- Marawha S.S. Asia Tech Publications

5. ELECTIVE-II

METABOLIC ENGINEERING

	Hrs		
Lectures	4hr/week	Examination	Marks
Practicals		Theory	:100

SECTION –I

UNIT-I Basic concepts of metabolic engineering (4)

a) Introduction to various pathways.

b) Primary and secondary metabolites.

c) Medical and agricultural importance of secondary metabolites.

UNIT-II Metabolic regulation (7)

Induction-jacob monod model, catabolite regulation, glucose effect, cAMP regulation, feed back regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, energy charge, permeability, control passive diffusion, active transport group transportation.

UNIT-III Metabolomics (4)

Bioinformatics for reconstruction of metabolic networks -metabolic pathway synthesis algorithms, examples of metabolic pathway manipulations, analyzing databases for metabolic pathways-KEGG

UNIT-IV Material and energy balances (7)

Stoichiometric models and matrix representation; the chemical reaction vector and energetic; material and energy balances revisited; basis for simplification of reaction; elemental balances;

component balances and the link with macroscopic measurements; examples of construction of elemental and component balances, thermodynamics of cellular processes – new concepts for quantitative bioprocess research and development**.**

SECTION –II

UNIT-V Metabolic flux analysis (10)

The theory of flux balances; Derivation of the fundamental principle; Degree of freedom and solution methods; Moore-Penrose inverse and Tsai-lee matrix construction; Examples of applications of flux analysis introduction Metabolic Control Theory; Control coefficients; Elasticity coefficients; Summation and connectivity theorems, Methods for experimental determination of metabolic fluxes by isotope labeling

UNIT-VI Genetic regulation of metabolic flux (4)

Gene expression in response to environmental stimulus, genetic tools for altering gene expression

UNIT-VIII Application of metabolic engineering (8)

Case study in pharmaceuticals, Fermentation, environmental bioremediation

Textbooks/Reference:-

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons 1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, Pergamon Press,1984.
3. COMPUTATIONAL Modeling of Genetic and Biochemical Network, by James M Bower & Hamid Bolouri.
4. Metabolic Flux analysis, by Valino.
5. Comprehensive Biotechnology, Vol-3, By Moo & Young.
6. Fundamentals of Biochemical Engg. by Baily & Olis.
7. Principles of Biochemical Engg. by Aiba & Humphery.
8. Biotechnology, by Black & Bra.
9. Zubay G., Biochemistry, Macmillan Publishers, 1989.
    - http://ocw.osaka-u.ac.jp/contents/19/ME040512.pdf
    - http://ocw.osaka-u.ac.jp/contents/19/ME040421.pdf
    - http://ocw.osaka-u.ac.jp/contents/19/ME040526.pdf
    - http://ocw.osaka-u.ac.jp/contents/19/ME040602.pdf
    - http://www.bioinfo.de/isb/gcb01/poster/hurlebaus.html
      How will bioinformatics influence metabolic engineering? Biotechnol Bioeng. 1998 , Apr 20-May 5;58(2-3):162-9
10. The metabolic pathway engineering handbook, smolke CRC Press (Taylor & Francis Group) edited by –Christina D Smolke(2010).

5. Elective-II

ADVANCED BIOMATERIALS

	Hrs		Examination Marks
Lectures	4 /week	Theory	: 100

SECTION-I

UNIT I

Introduction: (8)

Definition of biomaterials, requirements of biomaterials, classification of biomaterials and their applications for the human body. Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). physical and mechanical properties of biomaterials Surface properties of materials, biomaterial applications and tissue engineering for artificial organs.

UNIT II

Biocompatibility: (6)

Definition of biocompatibility, blood compatibility and tissue compatibility, biomaterials-blood (bio-fluid) interface, Surface modification for improved compatibility.

UNIT II

Cardiovascular System: (10)

Biomaterials in cardiovascular System, Collagen hyaluronic acid and other biopolymer applications, Cardiovascular implant biomaterials: artificial heart valves, Mechanicals and bioprosthetic valves, materials used, criteria required for fulfillment of physiological functions, Vessel grafts, Endothelial cell seeding as a surface modification of biomaterials.

Section II

UNIT II

Orthopedic implant materials: (6)

temporary external fixators, Materials for reconstruction of cartilage, ligaments and tendons, Bone replacement and bone cement, Artificial joint replacement

UNIT II

Ophthalmology: **(7)**

Anatomy and physiology of eye, Artificial cornea, contact lenses, intraocular lenses, artificial aqueous and artificial vitreous humour, artificial tears, artificial tympanic membrane, Tissue engineering and artificial organs, Properties of skin, Wound dressings

UNIT II

Artificial organs: (10)

Artificial skin, facial implants, dental restorative materials, implanted dental interfaced, Denture resins and cements, artificial red blood cells, artificial lung surfactants, artificial saliva, artificial synovial fluid, dialysis membranes, artificial liver, artificial pancreas, biodegradable block copolymers & their applications for drug delivery materials used for neuronal reconstruction and regeneration.

Textbooks/ 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 & Tissue Engineering: An Integrated Approach. Chapman & 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. Springer-Verlag.

6. SEMINAR-II

	Hrs	Examination Marks	
Lectures	---	Theory	:
Practical	2/week	Term Work	:25

The student shall deliver minimum one seminar (each 15 to 20 minutes) and submit seminar report to the department on different technical subjects during the semester. The assessment shall be based on

1) Seminar.

2) Seminar reports and

3) Questions & Answers during the seminar.

The faculty member / members shall guide the students in:

1) Selecting the seminar topics.

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) Preparation of the seminar report as per the guidelines of department.

4) Delivering the seminar.

7. PROJECT WORK

	Hrs	Examination Marks	
Lectures	---	Theory	:
Practical	4/week	OE	: 75
		Term Work	: 75

1. Project selected in first semester is to be continuing in second semester.
2. Minimum two progress reports to be submit to guide through semester.
3. Seminar on basis of project progress is to be given.
4. Evaluation on above basis marks is to be given.
5. For evaluation of external examination one external examiner is to be invited from other university or Industry.

Only for repeater students / Class Improvement Students
Syllabus for Elective -III
01. ADVANCES IN GENETIC ENGINEERING

	Hrs	
Lectures	3/ week	Examination Marks Theory 100 Practical External -- Internal --

Section I

Unit I (07)

Applications in mammalian genetic engineering, Biopharmaceuticals, restriction fragment length polymorphism(RFLP), DNA fingerprinting, human gene therapy

Unit II (07)

PCR technology, Gene amplification, inverse PCR, multiplex PCR, RT-PCR, application of PCR in mammalian genetic engineering.

Unit III (04)

Genetic diagnosis pulsed filed gel electrophoresis. Oligonucleotide synthesis, automated DNA sequencing.

Section II

Unit I (10)

Human Genome project. Man made antibodies, phage display. Application in other spheres of human genome project emphasized by selected articles. Yeast artificial chromosome.

Unit II (08)

Genetically modified organisms: Transgenic plants; Potential applications to improve production and food quality

Text/Reference Books:

1) PCR Protocols and applications (1990) Edited by M. A. Innis, D. H. Gelfand, J. J. Sninsky, T. J. White.
2) Genome Analysis – A practical approach (1988) Edited by K.E. Davies selected articles from Nature, Science, Cell etc.
3) Molecular Cloning- Volume II, Sambrook and Russell, Cold spring harbor University Press (2002).
4) Old R W and Primrose S B, Principles of gene manipulation, Blackwell scientific Publication, 1992.

Only for repeater students / Class Improvement Students
B.E. Part – II (Biotechnology)

Elective:-III

02. GOOD PRACTICES IN BIOTECHNOLOGY

	Hrs	
Lectures	3	Examination Marks
Practical --		Theory 100
		Practical
		External --
		Internal

Section I

- EC structure and tools
- Biotechnology and the law: summary of some current legislation in fore / Cartagna Protocol 1989 EDA rules.
- Good laboratory practice
- Guidelines for Microbial and animal cell cultivation.
- Safety and the genetic manipulation of organisms
- Scientific procedure using animals
- Radiation health and safety

Section II

- Patents and biotechnology
- Applying for marked authorization for medical products
- Manufacture and evaluation of medicinal products product
- Regulation of biotechnology in the food industry
- A general comment on the biotechnological production of chemicals other then medicines and food ingredients.

Reference Books:

1) Compendium of Good Practices in Biotechnology, BIOTOL series

2) Patent Strategy for Researchers and research managers – Knight, Wiley Publications.

3) Role of Patent and Patent information in Biotechnology inventions – Document of the international Bureau of world Intellectual Prosperity organization -1994

4) D. A. Shapton and R.G Board, 'Safety in Microbiology,' Academic Press, London, 1972.

Equivalence of subject of B. E. Part I & II [Biotechnology] under the Faculty of Engineering and Technology

Part I

Sr. No.	B.E. Part I Pre-revised	B.E. Part I Revised
1	Bioreaction Engineering	Bioreaction Engineering
2	Industrial Organization and Management	Pharmaceutical Biotechnology
3	Bioprocesses	Bioprocesses
4	Protein Engineering	Protein Engineering
5	Elective-I	Elective- I
6	Seminar	Comprehensive tests (On all subjects from S.E.to B.E.-I)
7	Industrial Practices	Industrial training at end of 6^{th} Semester (4Week)
8	Project Work	Project Work

Part II

Sr. No.	B.E. Part II Pre-revised	B.E. Part II Revised
1	Bioseparation Processes	Bioseparation Process
2	Bioprocess Engineering and Economics	Bioprocess Engineering & Economics
3	Bioprocess Modeling and Simulation	Bioprocess Modeling and Simulation
4	Elective-II	Elective- II
5	Elective-III	#Advances in Genetic Engineering
		#Good Practices in Biotechnology
6	Project Work	Project Work

Only for repeater students / Class Improvement Students