COURSE STRUCTURE
AND
DETAILED SYLLABUS

for
M.Tech course
in
BIOTECHNOLOGY

(with effect from the Academic year 2017-2018)

Department of Biotechnology (BT)

SREENIDHI INSTITUTE OF SCIENCE AND TECHNOLOGY

(An Autonomous Institution approved by UGC and affiliated to JNTUH)
(Accredited by NAAC with 'A' Grade, Accredited by NBA of AICTE, Recipient of WBA under TEQIP I & II)
Yamnampet, Ghatkesar, Malkagiri(Medchal)-501 301.

M.Tech (Biotechnology) - Course Structure

Choice Based Credit System
(Academic Regulations: 2017-18)
I YEAR - I Semester

I Year – I Semester:

Code	Subject	L	T	P	Credits	Internal marks	External marks	Total
7Q101	Microbial Engineering	3	1	--	3	25	75	100
7Q102	Molecular Biology & Virology	3	1	--	3	25	75	100
7Q103	Enzyme Engineering and Technology	3	1	--	3	25	75	100
	Preparatory core	3	1	--	3	25	75	100
7Q171	Research Methodology	2	--	--	2	25	75	100
	Professional Elective – I	3	1	--	3	25	75	100
	Professional Elective – II	3	1	--	3	25	75	100
7Q172	Molecular Biology and Immunology Lab	**--**	--	4	2	25	75	100
7Q173	Comprehensive Viva -I	--	---	--	1	50	50	100
7Q174	Literature Review and Seminar 1	-	-	3	1	100	--	100
Total Credits		**20**	**06**	**07**	**24**	**350**	**650**	**1000**

L = Lectures; T = Tutorial; P = Practical; C = Credits

Preparatory Core *

(One of these shall be allotted to each student depending on their background)

1. 7Q 111 Engineering Mathematics
2. 7Q104 Biochemistry & Metabolic Regulation

* **NOTE:**

1. Basic Engineering Mathematics is mandatory for all the students joining with their Masters in Life Sciences/Chemical Sciences/B. Pharmacy Graduates.
2. Biochemistry & Metabolic Regulation is mandatory for students having their B. Tech degree in Chemical Engineering.
3. B. Tech. (Biotechnology/Biochemical Engineering) students have the freedom to select any one of the two courses of their choice.

I Year – II Semester:

Code	Subject	L	T	P	Credits	Internal marks	External marks	Total
7Q211	Bioreactor Engineering	3	1	--	3	25	75	100
7Q212	Recombinant DNA Technology	3	1	--	3	25	75	100
7Q213	Bioseparation Technology	3	1	--	3	25	75	100
7Q214	Genomics and Proteomics	3	1	--	3	25	75	100
	Professional Elective – III	3	1	--	3	25	75	100
	Open Elective	3	1	--	3	25	75	100
7Q275	Comprehensive Viva -II	--	---	--	1	50	50	100
7Q276	Bioprocess Engineering Lab	**--**	--	4	2	25	75	100
7Q277	Literature Review &Seminar -2	--	--	3	1	100	--	100
7Q278	Project Seminar-I (Abstract)	--	--	3	2	100	--	100
Total Credits		**18**	**6**	**10**	**24**	**425**	**575**	**1000**

L - Lectures; T = Tutorial; P = Practical; C = Credits

Code	Open Elective
7Q218	Biosafety & IPR
7Q219	Nano Biotechnology
7Q220	Biosensors and Bioelectronics
7Q221	Renewable Energy Technologies
	General Management &Entrepreneurship
	Object-oriented programming through JAVA

II Year - I Semester:

Code	Subject	L	P	Credits	Marks		Total
					Int.	Ext.	
7Q379	Project Seminar-II	--	--	4	50	50	100
7Q380	Project work (Part – I) (Project Status Report)	--	--	20	Grading	--	--
Total Credits		**--**	**--**	**24**	**100**	**---**	**100**

Grading: A: Excellent, **B:** Good, **C:** Satisfactory, **D:** Unsatisfactory

II Year- II Semester:

Code	Subject	L	P	Credits	Marks		Total
					Int.	Ext.	
7Q481	Project Seminar-IV (Execution)	--	--	2	50	50	100
7Q482	Pre Submission Project Seminar (Final)	--	--	2	50	50	100
7Q483	Project work and Dissertation	--	--	20	--	**Grading**	**--**
Total Credits		--	--	**24**	**200**	**--**	**200**

Grading: **A:** Excellent, **B:** Good, **C:** Satisfactory, **D:** Unsatisfactory

Professional Elective-I			
S. No.	**Stream**	**Subject Code**	**Subject Name**
1	Medical Biotechnology	7Q105	Advanced Immunology
2	Plant Biotechnology	7Q106	Advanced Plant Biotechnology
3	Environmental Biotechnology	7Q107	Industrial Biotechnology
Professional Elective-II			
1	Medical Biotechnology	7Q108	Animal Biotechnology
2	Plant Biotechnology	7Q109	Natural Product Technology
3	Environmental Biotechnology	7Q110	Environmental Biotechnology
Professional Elective-III			
1	Medical Biotechnology	7Q215	Molecular Diagnostics & Therapeutics
2	Plant Biotechnology	7Q216	Molecular Markers & Crop Improvement
3	Environmental Biotechnology	7Q217	Food Biotechnology

I Year-I sem M.Tech (BT)
(7Q101) MICROBIAL ENGINEERING

L	T	P	C
3	1	-	3

Unit wise Course Outcomes Students will be able to	POs
1. Understand applications of Biochemical engineering & bioprocess techniques in Biotechnology	c, i
2. Understand Material & Energy balance and their importance	b
3. To understand importance of media optimization, statistical tools and sterilization	b
4. Explain the growth kinetics, electron balances related to biomass productivity	f
5. Understand and develop various models in microbial growth	b, c
6. Apply various microbial growth models for production of industrial biotech products	c, f

UNIT I: Introduction Introduction to biotechnology and biochemical engineering, bioprocess techniques, biotechnology products. Raw materials used for Industrial fermentation and its processing. Chemical, physical and physiochemical treatment.

UNIT II : Material balance and Energy balance Material balance- Thermodynamic preliminaries, system and process, steady state and equilibrium, law of conservation of mass, types of material balance problem, material balances with recycle and bypass streams, Energy balance-Basic energy concepts, intensive & extensive properties, Studies of enthalpy for reactive & non reactive processes. Heat of combustion, heat of reaction at Non standard conditions .Thermodynamics of microbial growth, energy balance equation for cell culture, unsteady state energy balance equations.

UNIT III : Medium optimization and Sterilization Medium optimization techniques with special emphasis on statistical techniques, Placket-Burman design, ANOVA, response surface methodology. Sterilization: Media sterilization: kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilisers, coupling of Arhenious equation and cell death kinetics, sterilization of air and filter design.

UNIT IV : Growth Stoichiometry Stoichiometry of bioreaction and energetic of microbial growth, Yield coefficients, Growth stoichiometry and elemental balances, electron balances, productivity and their correlation with the stoichiometry.

UNIT V : Unstructured Models Unstructed model for microbial growth. The development of different microbial growth kinetics like Malthus, Pearl and read, Monod Model, Konark Model. The limitation of Monod model and development of other constitutive models. Multisubstrate model, inhibition models for substrate, Product and toxic substances, development of logistic equation. Maintenance and endogenous metabolism kinetics.

UNIT VI: Structured Models Kinetics based on molecular mechanism, Model for Plasmid Structured models - a few examples, Single cell model, Product formation expression and replication, model of gene expression, Segregated model, Models of plasmid stability, Thermal death kinetics of cells and spores. Engineering and social considerations for the production of r-DNA products; Safety, Good Laboratory and manufacturing practices .Parameter estimation, Model validation and bioprocess optimization

TEXT BOOKS

1) Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986
2) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987

REFERENCES:

1) Biochemical Engineering Principles & functions, Syed Trnveer Ahmed Inamdar, PHI Learning Pvt Ltd.
2) Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication, 1999
3) Moser, A; Bioprocess technology, kinetics and reactors; Springer Verlag, Year of Publication1988
4) Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling & control; Springer–verlag, 2000

I Year-I Sem M. Tech (BT)

(7Q102) MOLECULAR BIOLOGY& VIROLOGY

L	T	P/D	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand various concepts of genetic material.	a
2. Understand DNA structure, stability and replication.	a, i
3. Comparison of replication and Transcription in prokaryotes and eukaryotes, various types of RNA, its synthesis and post transcriptional modifications in eukaryotes.	b, c, e
4. Understand Protein synthesis, protein turnover & factors governing their stability.	b, c, e
5. Concepts of RNA interference and their applications in *in vitro*	a, b, c
6. Classification, replication and pathogenesis of bacteriophages, plant and animal Viruses	a, c, d

UnitI: **DNA Structure and Replication:** DNA Structure, Replication and repair. Genes arrangement. Eukaryotic chromosome. Structure and replication, Repetitive DNA, CpG islands, Gene amplification, Extra chromosomal DNA (plasmids, transposable elements and TY elements).

Unit II: **RNA and Transcription:** Different classes of RNA and their functions. Transcription, splicing, post-transcriptional modifications, RNA export. Control of gene expression in prokaryotes. Transcriptional control in Eukaryotes.

Unit III: **Translation:** Protein synthesis, Protein turn-over and translational control.

UnitIV: **Modulation of Gene Expression:**
Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, RNAi, applications of antisense and ribozyme technology

UnitV: **General Virology:**Structure and replication of viruses, Replication of plant and animal viruses

UnitVI: **Viral Pathogenesis:** Disease and disease process- A note on SV40 and Retroviruses in transformation.

TEXT BOOKS:

1) Molecular Biology of the gene by Waston et al 4th edition.
2) Genes VI by Benjamin Lewis
3) Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press,2005.

REFERENCES:

1. Genetics by Ursula Good enough
2. Cytogenetics by Garl P. Swanson, Mertz & Young

I Year-I sem M. Tech (BT)

(7Q103) ENZYME ENGINEERING AND TECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Define and understand the nomenclature, classification, applications of the enzymes.	a,b
2. Understand the kinetics of enzyme reactions including different models	c,e
3. Apply enzyme catalysis and Mechanism of enzyme action in different enzyme systems and understand inhibition kinetics.	a,b,c
4. Explain the effect of Temperature and P^H dependence of rate constants.	b,c
5. Understand Pre-steady–state kinetics of enzymes.	b,c
6. Explain kinetics of immobilized enzymes, effect of external and internal mass transfer	c,f

Unit I: Introduction to Enzyme Engineering and Technology: Industrial Enzymes- their source, Isolation, characterization and their purification. Applications of enzymes in Industry, Medicine, Analytical Chemistry, Chemical, Pharmaceutical & Food Sectors. Specific activity, Turnover number. Basis of enzymatic reaction, collision theory and transition state theory.

Unit II: Enzyme Kinetics: Kinetics of single substrate enzyme catalyzed reaction, equilibrium, steady state assumption - Michaelis-Menten (Briggs- Haldane) equation. Transformation of Michaelis- Menten equation.The Lineweaver Burk, Eadie-Hofstee and Hanes plots. Determination of Vmax, Km, Kcat, Specificity constant (Kcat/Km) and their significance.

Unit III: Mechanism of Enzyme Catalysis and Inhibition: Nature and conformation of active site.Models for identification of functional groups essential for catalysis. Hydrolytic,covalent,acid-base,electrostaticandmetalioninvolvedcatalysis.Mechanism of enzyme action- Lysozyme, Carboxy peptidase, Chymotrypsin and Ribonuclease.Enzyme inhibition: Reversible inhibition-Competitive, Noncompetitive (pure, mixed) inhibition, Substrate inhibition, allosteric and irreversible inhibition. Feedback inhibition.

Unit IV: Energetics of Enzyme reaction: Temperature dependence of rate constants of enzymatic reaction, thermal deactivation, pH effect on rate constants and protein structure. Stoichiometry of bioreaction and energetic of enzymatic reaction, ATP and redox potential balance.

Unit V: The Steady State Kinetics: Pre-steady–statekinetics, determination of rate constants, rapid mixing, stopped flow and relaxation technique. Enzyme kinetics at limiting condition, enzyme kinetics at interface and kinetics of multi substrate reactions.

Unit VI: Immobilization of Biocatalysts and Modern Concepts: Immobilization of biocatalysts an introduction, Electrostatic Effect, effect of charged and uncharged support, Effect of external and internal mass transfer, Modern concepts of evolution of catalysis – catalytic RNA (Ribozymes), Abzymes (catalytic antibodies). Protein Engineering of Enzymes

TEXT BOOKS:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987.
2. Enzymes by palmer
3. Blanch HW and Clark DS: Biochemical Enginering, Marcel Decker

REFERENCES:

1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals
2. Schugerl K., Bellgart KH (Eds): Biorection Engineering, modeling and control: Springer-Verlag,
3. Wiseman, A: Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood publication
4. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag

I year - I semester M. Tech (BT)
(Preparatory Core)

(7Q111) ENGINEERING MATHEMATICS

L	T	P	C
3	1	-	3

UNITI:
Trigonometry- relations relatedto compound angles, multiple and sub-multiples, transformations, hyperbolic functions

UNITII:
Concepts of limit, continuity, differentiation, product rule, quotient rule. Differentiation of trigonometric, logarithmic, exponential functions.

UNITIII:
Applications of differentiation – problems on tangent, subtangent normal, subnormal. Introduction to partial differentiation, Euler's theorem.

UNITIV:
Introduction, Integration of different functions, methods of Integration, Integration by parts.

UNIT V:
Concept of definite integrals. Applicationsof definite integrals – problems on areas.

UNITVI :
Forming of differential equation by eliminating arbitrary constants, first order and first degree – variables and seperables, exact, homogeneous and linear.

Textbooks:

1. Engineering Mathematics	-	N.P. Bali and others.
2. Engineering mathematics	-	B.V. Ramana

References:

1. Differential Calculus	-	Shanthi Narayan
2. Integral Calculus	-	Shanthi Narayan

I year - I semester M. Tech (BT)

(Preparatory Core)

(7Q104) Biochemistry & Metabolic Regulation

L	T	P	C
3	1	-	3

Unit wise Course Outcomes Students will be able to	POs
1. Understand bioenergetics and the importance oxidation-reduction potentials in metabolic reactions	a,b
2. Explain metabolism and regulation of Carbohydrates and Nucleic acids	c,e
3. Explain metabolism and regulation of Proteins and Lipids	a,b,c
4. Understand and explain Metabolic regulation	b,c
5. Explain Membrane transport and cell signaling pathways	b,c
6. Understand the importance of protein sorting and transport	c,f

UNIT-I BIOENERGETICS: General laws of thermodynamics, Coupled Reactions, High energy phosphates; Biological oxidation – Redox Potentials, oxidases, dehydrogenases, non-equilibrium metabolic reactions.

UNIT-II METABOLISM OF MACROMOLECULES – I: Carbohydrates- Glycolysis, aerobic and anaerobic fate of pyruvate, Oxidative phosphorylation, Glucoenogenesis, pentose phosphate pathway, glycogen metabolism. Nucleic acids- Purine synthesis and catabolism. Pyramidine synthesis and catabolism.

UNIT- III METABOLISM OF MACROMOLECULES – II: Proteins– Transamination, Deamination, Oxidative deamination, Urea cycle. Aminoacids- Biosynthesis of non-essential aminoacids, catabolism of aminoacids. Lipids- Fatty acid synthesis, β-oxidation of fatty acids

UNIT-IV Regulation of Metabolic Pathways: Coordinated regulation, Hormonal Regulation and Integration of fuel Metabolism, Inborn errors of metabolism-diagnosis and treatment. Metabolic Control Analysis: Quantitative Aspects. Tissue-Specific Metabolism - Assays for Tissue Damage.

UNIT-V TRANSPORTATION IN BIOMEMBRANES, SIGNAL TRANSDUCTION: Structure of plasma membranes. Transportation of molecules across plasma membrane. Modes of cell signaling, Types of receptors used for cell signaling, pathway of intracellular signal transduction using secondary messengers, Apoptosis

UNIT-VI PROTEIN TARGETING: Protein synthesis, Co-translation and post translation of proteins. Protein targeting

TEXT BOOKS:

1. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
2. Biochemistry L. Stryer

REFERENCE BOOKS:

1. Biochemistry White, Handler and R.B. Smith.
2. Principles of Biochemistry A. Lehninger
3. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand andCo. Ltd.

I Year-I sem M. Tech (BT)
Professional Elective – I
(7Q105) Advanced Immunology

L	T	P	C
3	1	-	3

Unit wise Course Outcomes Students will be able to	POs
1. Understand the process of Innate immunity and the cells and mediators that drive the inflammatory process.	a
2. Be proficient in signal transduction mediated by key cytokines of the immune response.	a
3. Differentiate between two key subsets of T helper cells and their role in immunity which will help in designing therapeutic strategies for various diseases.	a, d
4. Have comprehensive understanding of the important phenomenon of immunological tolerance i.e., the discrimination between the self and the basis of autoimmune disorders.	a, d
5. Have thorough understanding of cancer immunity and vaccination strategies and other immunotherapies for cancer which gives an impetus to indulge in formulating immunotherapeutic approaches for cancer.	a, d
6. Be proficient in immunity related to infections including bacterial, viral and fungal etc. This knowledge will help them to develop a solid platform to identify relevant therapeutic strategies for diverse diseases namely influenza, malaria, swine flu and others which are afflicting the humans.	a, d

Unit I: Innate immunity and inflammation : Pathogen-associated molecular patterns (PAMPs) and their recognition by innate immune system receptors with special emphasis on Toll-like receptors. Phagocytosis and inflammation. Role of cytokines, chemokines and adhesion molecules such as ICAM, integrins and selectins in inflammation

Unit II: Signal transduction: Adaptor proteins, protein kinases, transcription factors and gene activation. Study with reference to IFN-gamma and TNF-alfa.

Unit III: T-helper cell subsets and their role in immunity: Th cell subsets determine the type of immune response. Th-1 versus Th-2 cytokine profile. Therapeutic strategies based on tilting the balance of Th-1 and Th-2 cell subsets.

Unit IV: Immunological tolerance and autoimmunity: Central tolerance, pheripheral tolerance. Failure of tolerance leading to autoimmunity. Mechanisms for autoimmunity induction. Organ-specific and systemic autoimmune diseases.

Unit V: Cancer immunology and immunotherapy: Immunosurveillance and cancer. Mechanisms that downregulate tumour immunity. Vaccination strategies for cancer with special emphasis on recent concepts like vaccination with dendritic cells pulsed with peptides and adoptive immunotherapy using T cells.

Unit VI: Immunity to infection and vaccination strategies: Innate immune mechanisms that restrict early stages of infection. Interferons, NK cells and dendritic cells. Adaptive immunity – Cytotoxic T cell-mediated killing mechanisms. Microbial strategies to evade immune response. Vaccination strategies to viral infections – human, avian and swine influenza viruses, hepatitis B and HIV viuses. Strategies

TEXT BOOKS

1. "Essential Immunology" by Ivan M. Roitt (1980). (Blackwell Scientific Publications, Oxford, London) fourth edition
2. "Immunology" by Ivan M. Roitt, Jonathan Brostoff and David K. Male (1985) (Glower Medical Publishing, London) first edition.
3. Vaccination for tuberculosis and malaria."Immunology Today".
4. Current topics in Microbiology & Immunology

I Year-I sem M. Tech (BT)

Professional Elective – I

(7Q106) ADVANCED PLANT BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Ability to explain the various components of plant tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components	a, d,e
2. Ability to explain the various steps taken to establish and optimize media for particular purposes in particular species, without the aid of texts, e.g. for callus culture & direct regeneration	a,d,e
3. Ability to explain and perform some of the more advanced techniques, e.g. embryo rescue, anther culture and protoplast isolation/culture.	a,d,e, i
4. Ability to establish & maintain plants in tissue culture & micro propagation, including morphogenesis	a,d,e
5. Ability to Investigate & define protocol to establish cultures of unknown species & test its in vitro response	a,d,e,i
6. Ability to explain the various cell lines used in tissue culture and their origins and uses	a,d,e, i

UNIT I: Cell and Tissue Culture: Concept of Totipotency, Tissue culture media (composition, preparation); Initiation and maintenance of callus and cell suspension culture, Somatic embryogenesis, Organogenesis; Clonalpropagation

UNIT II: Tissue Culture Applications: Protoplast isolation, culture fusion and somatic hybridization; Haploid Production, its application and limitations; Somaclonal variations; Short term and long term Germplasm conservation

UNIT III: Production of Phytochemicals: Production of chemicals and other important compounds from plant cell cultures; Strategies for enhancing product yield; Bioreactor systems for mass cultivation of plant cells and production of Phyto-pharmaceuticals (Shikonin, Berberine, Ginsenosides)

UNIT IV: Transformation Technology: Promoters, Selectable markers, reporters involved in transformation, genetic transformation techniques;*Agrobacterium* mediated gene transfer; Direct gene transfer methods - chemical methods, electroporation, microinjection and particle bombardment, gene silencing in plants

UNIT V: Transgenic Plants: Production of transgenic plants forAbiotic (Drought, temperature, salt) and Biotic (Herbicide resistance, Insect resistance, Disease resistance, Virus resistance) stress tolerance

UNIT VI: Molecular Farming: Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic proteins, Antigens (edible vaccine) and Plantibodies.

TEXT BOOKS:

1. Roberta Smith, Plant Tissue Culture: Techniques & Experiments. 2nd ed., Acad. Press, 2000.
2. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. Elsevier Science, 2004
3. H. S. Chawla, Introduction to Plant Biotechnology, 3rd Edition, Science publishers, 2009

REFERENCES:

1. Bhojwani, S.S., Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier,1990.
2. Charles Cunningham and Andrew J.R. Porter, Recombinant Proteins from Plants: Production & Isolation of Clinically Useful Compounds (Methods in Biotechnology), Humana Press, 1997.
3. Bernard R. Glick and John E. Thompson, Methods in Plant Molecular Biology and Biotechnology, CRC Press, 1993.
4. I. Potrykus and G. Spangenberg, Gene Transfer to Plants (Springer Lab Manual), Springer Verlag, 1997.
5. John Hammond, Peter Mc Garvey, VidadiYusibov, Plant Biotechnology: New products and applications, Springer verlag, 1999.

I Year-I Sem M. Tech (BT)

Professional Elective – I
(7Q107) INDUSTRIAL BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to 1. Understand the importance of industrial microorganisms and their bioprocess development. 2. Explain the upstream and downstream processes of industrially important primary metabolites. 3. Explain the upstream & downstream processes of industrially important secondary metabolites. 4. Know different industrial enzymes and their large scale production strategies. 5. Understand the production of low-volume-high-value recombinant products 6. Explain the importance of producing eco-friendly industrial products.	

UNIT I: Introduction: Bioprocess-overview, Industrially important microorganisms, strain improvement, Dual or multiple fermentation

UNIT II: PRODUCTION OF PRIMARY METABOLITES - Organic acids -Citric acid, Lactic acid, Amino acids -Glutamic acid, Phenylalanine, Alcohols –Ethanol, 2,3-Butanediol

UNIT III: PRODUCTION OF SECONDARY METABOLITES: Antibiotics-Penicillin, Streptomycin, Erythromycin, Vitamin B_{12}

UNIT IV: ENZYMES: Production and applications of Industrial Enzymes **-** Proteases, Amylases, Lipases, Cellulases. Enzymes in food and pharmaceutical industries;

UNIT V: RECOMBINANT PROTEINS: production of r-DNA based products – Monoclonal antibodies (mAb's) Production of recombinant proteins - Insulin, IL2, recombinant vaccines- Hepatitis

Unit VI: Ecofriendly Products

Bioplastics - Polyhydroxy Alkanoates, Poly Lactic acid, Xanthan, Biofertilizers, Biopesticides, Biosurfactants,

TEXT BOOKS:

1. Industrial Biotechnology: Sustainable Growth and Economic Success edited by Wim Soetaert, Erick J. Vandamme published by John Wiley & Sons. 2010
2. Basic Industrial Biotechnology, SM Reddy, S.Ram Reddy, G. Narendra Babu , New age international Publishers. 2012

REFERENCES:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA , Bernard R. Glick, Jack J. Pasternak, ASM Press

I Year-I sem M. Tech (BT) Professional Elective – II

(7Q108) ANIMAL BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Course Outcome

1. Student will be able to OPERATE the Equipment and prepare media for Mammalian Cell Culture
2. Student shall be able to conduct Enzymatic digestion to differentiate cell types , and Perform preservation of cells
3. Student will be able to formulate the viability and cytotoxicity studies and to identify cell types on their characteristics
4. Students will be able to gain knowledge in scaling up and apply in them
5. Students shall be able explain animal breeding techniques
6. Students shall be able to identify & treat animal diseases and design transgenics .

Unit I: Animal cell culture and Media: Media-balanced salt solution and simple growth medium, Role of serum, Serum and protein free media, cell growth factors, Equipments and materials for animal cell culture , Chemical, physical and metabolic functions of different constituents of culture medium – Over View

Unit II: Establishing Cell lines: Cell culture techniques, disaggregation of tissue-trypsinization, Primary and established cell lines, maintenance of cell culture, cell separation, Cryopreservation, Stem cells –Types and applications

Unit III: Cell Viability: Measurement of viability and cytotoxicity, Biology and characterization of the cultured cells, measuring parameters of growth, apoptosis and necrosis

Unit IV: Cell synchronization: Cell synchronization, cell transformation, applications of animal cell culture- vaccines, Cell culture based recombinant products- scaling up of animal cell culture

Unit V: Induced animal Breeding: Introduction, artificial insemination, cloning, in-vitro fertilization and embryo transfer, nuclear transplantation, selective animal breeding, micromanipulation technology and breeding of farm animals.

Unit VI: Transgenic Animals: Concept of Transgenics, strategies for Production of transgenic animals-mouse, fish, sheep, stem cells in production of transgenics, Recombinant cytokines and their use in the treatment of animal infections, ; monoclonal antibodies and their use in diagnosis, gene therapy for animal diseases.

TEXT BOOKS:

1. Culture of Animal Cells, (3rd Edition), F1. Ian Freshney, Wiley-Liss
2. Animal Cell Culture-Practical approach, Ed. John R.W.Masters, Oxford
3. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

REFERENCES:

1. Cell Culture Lab Fax. Eds.M.Butler & M.Dawson, Bios Scientific Publications Ltd, Oxford
2. Animal Cell Culture Techniques, Ed. Martin Clynes, Springer
3. Methods in Cell Biology, vol 57, Animal Cell Culture Methods, Ed. Jenni P, Mather and David Barnes, Academic press

I Year-I sem M. Tech (BT)

Professional Elective – II

(7Q109) PHYTOCHEMICALS AND HERBAL MEDICINE

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand the importance and types of Phytochemicals	a, d,e
2. Understand the distribution and cultivation methods of Medicinal and aromatic plants and differentiate them based on their status of existence.	a,d,e
3. Differentiate& Identify different phytochemicals based on their extraction & estimation methods	a,d,e, i
4. Explain various medicinal plant conservation methods with specific examples	a,d,e
5. Compare, Analyze and Evaluate various Phytochemicals	a,d,e,i
6. Understand various applications of Phytochemicals in different industries	a,d,e, i

Unit I: Phytochemicals: Historical perspective, Scope & Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological and molecular); Cultivation, Collection & processing of Crude Drugs. Indian systems of medicine (AYUSH)

Unit II: Medicinal & Aromatic Plants: Cultivation Utilization and geographical distribution of Medicinal & Aromatic Plants in India.Endemic, Threatened & Endangered Medicinal flora.

Unit III: Screening & Separation of Phytochemicals: Extraction methods of Carbohydrates & Derived Products; Glycosides (*Digitalis*, *Aloe*, *Dioscorea*,); Tannins (Hydrolysable & Condensed types); Volatile Oils (Clove, *Mentha*), Alkaloids (*Taxus*,*Papaver*, Cinchona); Flavonoids, Phenolics (Caffeic acid, Chlorogenic acid)& Resins.

Unit IV:Conservation ofMedicinal Plants: Plant Tissue Culture as source of medicines, Plant Tissue Culture for enhancing secondary metabolite production (*Withaniasomnifera*, *Rauwolfiaserpentina*, *Catheranthusroseus*, *Andrographispaniculata*, *Dioscorea* sp.); Anticancer drugs (Taxol, Vicristin, Vinblastin, Camptothecin)

Unit V:Drug Analysis &Evaluation Methods: Morphological, Microscopic, Physical & Chemical methods; Preliminary screening, Assay of Drugs – Biological evaluation / assays, Microbiological methods.Chemical estimations, Spectrophotometry & Fluorescence analysis.Drug adulteration – Types of adulterants.

Unit V: Applications of Phytochemicals: Application of phytochemicals in industry and healthcare; Pharmacological action of few secondary metabolites, Biocides, Biofungicides, Biopesticides

TEXT BOOKS:

1. Pharmacognosy, C. K Kokate, A. P Purohit & S. B. Gokhale (1996), Nirali Prakashan, 4th ed.
2. Natural Products in medicine: A Biosynthetic approach (1997), Wiley.

REFERENCES:

1. Hornok, L. (ed.) (1992). Cultivation & Processing of Medicinal Plants, Chichister: J. Wiley & Sons.
2. Trease & Evans, Pharmacognosy – William Charles Evans, 14th ed. (1989), Harcourt Brace & Company.

I Year-I sem M. Tech (BT)
Professional Elective – II
(7Q110) Environmental Biotechnology

L	T	P	C
3	1	-	3

Course Outcomes

1. Student shall be able to gain knowledge and apply the biotechnological techniques of pollution control mechanisms
2. Student shall be able to perform the biotechnological methods of water and soil bioremediation
3. Student shall be able to understand the methods of production of biofuels
4. Student shall be able to identify and detect the toxicants in environment
5. Student shall be able to understand methods of bioleaching
6. Student shall be able to plan and manage issues related to environment

UNIT I: Industrial Pollution and Control: Issues and scope of Environmental biotechnology, Biotechnology in abatement of air pollution and odour control - Bioscrubbers, Biobeds, biotrickling filters. Use of microorganisms and enzymes in wastewater treatment, EBT for pollution detection and monitoring.

UNIT II: Bioremediation and Biodegradation: Concept of bioremediation, types of bioremediation, characteristics of microbial metabolism (enzymatic process and non-enzymatic process), soil bioremediation – in situ and ex situ techniques.

UNIT III: Bioenergy: Production of biofuels-methane, hydrogen, ethanol, biodiesel from biomass and microalgae, bioaugmentation of petroleum recovery

UNIT IV: Environmental Toxicology: Introduction, Definition, classification, factors affecting toxicity, Effects of toxicants on ecosystem, Types of bioassays (Ames test, bioluminescence, algal toxicity, special analyses such as biomarkers, bioaccumulation, mesocosm and microcosm studies).

UNIT V: Metal Biotechnology: Bioleaching – Mechanism and its types. Bioleaching of copper, uranium, Biosorption of heavy metal , strategies of heavy metal resistance, phytoremediation of heavy metals.

UNIT VI: Environmental Management System: Definitions , Scope and Objectives of EMS - ISO and ISO 14000 series, Types of Environmental Impact Assessment (EIA), Environmental auditing, Environmental Management Plan (EMP), Geographical Information System in environmental management

TEXT BOOKS:

1. Waste Water Treatment- M.N.Rao
2. Bioremediation and Biodegradation- Martin Alexander
3. Modern Toxicology by Gupta and Salunkhe.
4. Environmental Impact Assessment – Canter.

REFERENCE BOOKS

1. Water and Wastewater Treatment-Metcalf and Eddie
2. Industrial biotechnology -problems and remedies , Indu shekar Thakur IK international Pvt.ltd. 2006

I Year-I sem M. Tech (BT)
(7Q171) RESEARCH METHODOLOGY

L	T	P	C
2	-	-	2

Outcome

1) Study the concepts of Research, Characteristics and Prerequisites of research, Research needs in Engineering, Education, Science and Management.

2) Study the concepts of conducting a literature search, Evaluating, Organizing, and synthesizing the literature.

3) Identifying and describing the research, finding the research Problem, Sources of research problem

4) Perform Quantitative / Qualitative Research Design, basic principles of research design.

5) Familiar with concept of formatting a research proposal.

6) Familiar with writing Research report

UNIT-I Research Methodology: An Introduction

Meaning of Research, Objectives of Research Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method. Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India,

UNIT-II Defining the Research Problem

What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration, Conclusion .

UNIT-III Research Design

Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Developing a Research Plan, Conclusion.

UNIT-IV Sampling Design

Census and Sample Survey, Implications of a Sample Design, Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of Sample Designs, How to Select a Random Sample, Random Sample from an Infinite Universe, Complex Random Sampling Designs, Conclusion.

UNIT-V Methods of Data Collection

Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data.

UNIT-VI Concept of Hypothesis and Testing

What is a Hypothesis? Basic Concepts Concerning Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses. Important Parametric Tests, Hypothesis Testing of Correlation Coefficients, Limitations of the Tests of Hypotheses, Chi-square as a Test for Comparing Variance, Chi-square as a Non-parametric Test, Conditions for the Application of $\chi 2$ Test, Steps Involved in Applying Chi-square Test.

Text Books

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, Vishwa Prakashan, 2006

2. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0,2006

Reference Books

1. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.

I Year-I sem M. Tech (BT)

(7Q172) Molecular Biology and Immunology Lab

L	T	P	C
-	-	4	2

Experiment wise Course Outcomes	POs
Students will be able to 1. Isolate and purify genomic DNA 2. Extract & Purify Plasmid DNA 3. Understand Restriction Digestion & Ligation of DNA 4. Perform transformation, cloning of DNA/gene and screen for recombinant clones 5. Perform Differential Leucocyte Count 6. Understand Immunodiffusion 7. Perform ELISA and explain its applications 8. Perform SDS PAGE and explain its applications 9. Understand Blotting techniques 10. Understand FACS and its applications	**b, c, d**

Molecular biology

1. Extraction and purification of genomic DNA
2. Extraction and purification of plasmids
3. Restriction digestion and Ligation of DNA
4. Transformation
5. Southern blotting

Immunology

1. Differential leukocyte count
2. Immunodiffusion techniques
3. Enzyme-linked immunosorbent assay (ELISA)
4. Immunoprecipitation
5. SDS – polyacrylamide electrophoresis
6. Western blotting
7. Immunoflluorescence
8. Fluorescence-activated cell sorting

I year – II semester M. Tech(BT)
(7Q173) COMPREHENSIVE VIVA-I

L	T	P	C
-	-	-	1

Course Out Comes:

1. Students will be able to develop ability to recapitulate CAD/CAM Engineering concepts and reproduce them orally.

2.The main aim of Comprehensive Viva-Voce is to assess the students understanding in various subjects he / she studied during the M. Tech. course of study.

There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the students' understanding in various subjects he/she studied during the M.Tech course of study. The Comprehensive Viva-Voce is valued for 50 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce. A candidate has to secure a minimum of 50% to be declared successful.

I year – II semester M. Tech(BT)

(7Q174) - LITERATURE REVIEW & SEMINAR-1

L	T	P	C
-	-	3	1

Course Outcomes	POs
Students will develop ability to	
1. Identify a research topic,	a,i
2. Collect literature	d,i
3. Write technical review paper	c,d,h,i,k
4. Present seminar	d,h,i,k
5. Discuss the queries and	d,h,k
6. Publish research paper	d,h,i,k

There shall be two seminars presentations during I year I semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a chosen topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Review Committee (DRC), which shall consist of the Head of the Department, a senior Faculty Member and the Supervisor and will jointly evaluate the report and presentation. For each Seminar there will be only internal evaluation of 25 marks. A candidate has to secure a minimum of 50% to be declared successful.

In the First seminar, the report must be in the form of the review paper with a format used by IEEE / ASME etc. In the Second Technical Seminar in the form of Independent Review Paper must be of high quality fit for publication in a reputed conference / journal.

The evaluation format for each seminar is as follows:

- Day to day evaluation by the Supervisor : 5 marks
- Final Report : 5 marks
- Presentation : 15 marks

A Student has to concentrate on the following sections while writing technical paper or presenting seminar.

Contents:

- Identification of specific topic
- Analysis
- Organization of modules
- Naming Conventions
- Writing style
- Figures
- Feedback
- Writing style
- Rejection
- Miscellaneous

References:

1. Teach Technical Writing in Two Hours per Week by Norman Ramsey (For Technical Seminar the student must learn few tips from sample seminars and correcting himself, which is continues learning process)
2. Reference Links:
   http://www.cs.dartmouth.edu/~scot/givingTalks/sld001.htm
   http://www.cse.psu.edu/~yuanxie/advice.htm
   http://www.eng.unt.edu/ian/guides/postscript/speaker.pdf

I year – II semester M. Tech (BT)
(7Q211) BIOREACTOR ENGINEERING

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand types of bioreactors and modes of their operation	d
2. Study growth of microbes in different bioreactors	d,f
3. Ability to understand design features of Bioreactors,	d,f
4. Apply Gas-Liquid-mass transfer in cellular systems, online and offline monitoring of bioreactors	b,c
5. Understand concepts of Newtonian and non Newtonian fluids, power requirement for aerated and non aerated reactors	b,c,d
6. Scale up and scale down mass transfer equipments and use different types of reactors for microbial, plant and animal cell systems	b,c,d

UNIT I: Bioreactors
Bioreactor function. Utility, types of bioreactors. Modes of bioreactor operations, Main components of the bioreactor and their function. Introduction methods of Aeration, surface aeration, Mechanical stirred bioreactors.

UNIT II :Reactor Kinetics
Immobilized biocatalysts , methods of immobilization, kinetics of immobilized enzymes, Enzyme catalysis in CSTR. Cell death in batch reactor, endogenous metabolism, maintenance, product and substrate inhibition on chemostat.

UNIT III: Bioreactors and design features
Batch reactor, Chemostat CSTR, Plug Flow Reactor, Fed batch reactor, Bubble column, bubble generation at an orifice, bubble coalescence and breakup, gas holdup interfacial area, immobile and mobile gas liquid interface, regimes of bubbles, design of bubble columns, Cascade reactor, air left reactor, Fluidized bed bioreactors, trickle bed reactors Immobilized bioreactors, recycle bioreactors.

UNIT IV: Gas- liquid mass transfer
mass transfer in cellular systems, basic mass transfer concepts, solubility of gases (O,CO_2) in biological media, mass balances for two-phase bioreactor. Mass transfer – introduction to mass transfer between phases, mass transfer in porous solids, quantifying mass transfer, mass transfer & experimental design. Oxygen transfer-introduction, oxygen transfer process, factor effecting k_La interfacial area and oxygen transfer, factors effecting the saturation concentration of oxygen, oxygen uptake.

UNIT V: Mass transfer in agitated tanks
Correlations with k_La , Newtonian and Non Newtonian liquid, Power number. Experimental determination of k_La, static method, dynamic method, chemical method. Power requirement for mixing in aerated and non aerated tanks, agitated and non-agitated tanks for Newtonian and non Newtonian fluid.Mixing time in agitated reactor, residence time distribution.Non ideal reactor and multiphase bioreactor.

UNIT VI: Aeration and Agitation in Animal cell bioreactors
Introduction. Cell damage in animal cell bioreactors , shear damage , bubble damage. Method of minimizing cell damage. Laminar & Turbulent flow in stirred tank bioreactors, turbulent eddies, kolmogrov eddy size. Preventing vortex formation, Off - centreimpellers,baffles Control of bioreactor, strategy, online and offline monitoring of bioreactors: computerized bioprocess control. Scale up and scale down of mass transfer equipment and bioprocess control of bioreactor, sensor used in the bioreactor, pH, O_2,CO_2 electrode, Online sensors for cell properties. Direct regulatory control and cascade control mechanism.

TEXT BOOKS:

1. Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986
2. Blanch HW and clark Ds: Biochemical Engineering Marcel Decker Year of Publication 1987
3. Introduction to Biochemical Engineering by D G Rao Tata Mc Graw Hill, New Delhi.

REFERENCE BOOKS:

1. Wiseman A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication, 1988.
2. Moser, A:Bioprocess technology, Kinetics and reators: Springer Verlag., Year of Publication 1988
3. Schugerl K: Bellgart K H (Eds): Bioreaction Engineering, Modeling and control, Springer – verlog, berlin Year of Publication 200G.
4. Biochemical Engineering Principles and functions by Syed Tmveer Ahmed Inamdar,PHI Learning Private Limited.

I year – II semester M. Tech(BT)

(7Q212) GENETIC ENGINEERING AND APPLICATIONS

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Ability to demonstrate the expression of Genes in prokaryotes and Eukaryotes.	b,
2. Ability to demonstrate types, Classification, Identification and Transfer of Plasmids and to study the definition, detection of transposition and Retrotransposons.	b
3. Ability to demonstrate types of DNA vectors and their construction and usage	c,
4. Ability to understand the concept of recombinant DNA technology or genetic engineering	e,
5. Ability to demonstrate expression and detection Of Clones	h
6. Ability to apply principles, designing of primers, PCR methodology of various types of PCR variants	c

UNIT I: Nucleic Acid Isolation and Sequencing: Nucleic Acid Purification, Yield Analysis. Sequencing methods – Sanger's, Maxam - Gilbert's method. Automated sequencing. Full genome sequencing, Nucleic Acid Amplification and its Applications

UNIT II: Molecular Tools in Genetic Engineering: Molecular Tools in genetic engineering: Restriction enzymes, ligases, Linkers, adaptors and their chemical synthesis, s1 nuclease, terminal deoxy nucleotides, transferases, Poly A polymerases. , Alkaline Phosphatase etc., Modification enzymes, DNA, and RNA markers.

UNIT III: Cloning Vectors: Nucleic Acid Sequencing. Gene Cloning Vectors: Plasmids bacteriophages, phagemidscosmids, viral vectors, Artficial chromosomes. Cloning mRNA enrichment, reverse transcription. Restriction Mapping of DNA Fragments and Map Construction

UNIT IV: Cloning Strategies: Strategies of Gene cloning Cloning, reverse transcriptase, interacting genes, library construction and screening. Genomic libraries (complete sequencing projects).. Two-and three hybrid systems, cloning differentially expressed genes Site-directed Mutagenesis and Protein Engineering.

UNIT V: Gene Expression: Gene Regulation, DNA transfection, Northern blot, Primer extension. S1 mapping, RNase protection assay. Reporter assays. Nucleic acid microarrays. Expression Strategies for Heterologous Genes, Vector engineering and codon optimization. Host engineering, In vitro transcription and translation, expression in bacteria expression in prokaryotic and eukaryotic cells, expression in plants.

UNIT VI: Applications: Phage Display T-DNA and Transposon Tagging Role of gene tagging in gene analysis, Transgenic and Gene Knockout Technologies. Targeted gene replacement. Gene Therapy Vector Engineering of gene delivery, gene replacement augmentation, gene correction gene editing, gene regulation and silencing.

TEXT BOOKS:

1. Molecular and cloning : a laboratory Manual J Sambrook EF Fritsch and T.maniatis cold Spring Harbor laboratory Press, New York 2000
2. DNA Cloning a Practical Approach M.Glover and B.D.Hames, IRL Press, Oxford 1995

REFERENCE BOOKS:

1. Molecular and Cellular Methods in Biology and Medicine, P.B.Kaufman, W.WuD.Kim and 1.j: Cseke, Cre Press, Florida, 1995.

2. Methods in Enzymology vol.152 Guide to Molecular Cloning Techniques. S.I. Berger and a.R.Kimmel, Academic press Inc San diego, 1998.
3. Methods in Enzymology vol 185. Gene expression technology, D.V. Goeddel, Acdemic Press Inc.San Diego 1990.

I year – II semester M. Tech (BT)

(7Q213) BIOSEPARATION TECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Demonstrate fundamentals of downstream processing for biochemical product recovery. Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future. Analyze both analytical and process validation issues that are critical to successful manufacturing, focusing on large-scale, high-purity protein production.	d, f,
2. Address various unit operations of downstream processing such as sedimentation, centrifugation, cell disruption, filtration, Flocculation and coagulation.	e
3. Understand about Membranes and their applications in bioprocess industries.	e,f
4. Demonstrate different types of precipitation & Electrophoresis Techniques in purification of biomolecules.	e
5. Demonstrate various chromatographic techniques such as Paper, TLC, GC, HPLC, etc…	e
6. Demonstrate applications of downstream process operations with case studies.	f

UNIT-I: **Down Stream Processing of Bioproducts:** Down Stream Processing (DSP) in biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics.
Cell disruption methods: Various cell disruption methods, need for cell disruption for intracellular products cell disruption equipment. Applications in bio-processing.

UNIT-II: Sedimentation, Filtration and Centrifugation: Solid –Liquid Separation: Filtration: Principles filter aids, constant volume filtration, constant pressure filtration, specific cake resistance equivalent cake thickness. Filtration equipment viz. plate and frame filter press, vacuum filters, leaf filters. Sedimentation: Principles of particle setting, batch sedimentation equipment via: thickener.
Centrifugation: Principles of centrifugation, centrifuge effect, g-number, sigma factor, various centrifuges via basket centrifuge, tabular centrifuge disc-bowl centrifuge, scale-up of centrifuges.

UNIT-III: Adsorption and Drying: Adsorption: Adsorption and adsorption processes, adsorption equilibrium and isotherms, principles of adsorption and equipment, applications.
Foaming, Flocculation and Coagulation: Principle and applications in bioprocessing. Freeze drying technique and its advantages over other methods, Applications in bio-processing.

UNIT-IV: Purification Techniques I: Membrane separations processes: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.
Precipitation: Precipitation: Principles of precipitation, precipitation equipment, applications in bio-processing.

UNIT V: Purification Techniques II: Chromatography: Chromatographic separation and electrophoresis methods: Principles of chromatographic separation methods, different types of chromatographic methods, via adsorption chromatography, ion-exchange chromatography, gel chromatography, affinity chromatography etc. Applications in bioprocessing.

UNIT VI: Liquid Liquid Extraction: Extraction process and principles phase equalitarian and distribution, batch and continuous extraction, co-current and counter current extraction processes, LLE equipment. Applications in biotechnology.

TEXT BOOKS:

1. Bioseparations (Principles and Techniques) By Sivasanker, Prentice Hall of India Pvt. Limited
2. Principles of fermentation technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications.

REFERENCE BOOKS:

1. Separation Process in Biotechnology edited by juan A. Asenjo, Taylor & Francis Group
2. Comprehensive Biotechnology Vol 2 Ed: M Moo-young (1985)
3. Product Recovery in Bioprocess technology, Biotol series, Butterworth-Heinemann

I year - II semester M. Tech (BT)
(7Q214) GENOMICS AND PROTEOMICS

L	T	P	C
3	1	-	3

Unit wise Course Outcomes Students will be able to	POs
1. Understand the concept of Nucleotide Sequencing Methods and their application in Human Genome Project and other model organisms	b,
2. Understand protein sequencing methods and gain insight into various protein interactions	b,
3. Gain knowledge in Gene Prediction Methods and Micro array technology	c,
4. Understand the importance of various Genomic Tools	e,
5. Understand the importance of various Proteomic Tools	e
6. Apply the concepts of Genomics and Proteomics in Drug development	c

UNIT I: INTRODUCTION TO GENOMICS: Nucleotide sequencing methods Chemical, enzymatic, Next Gen sequencing methods; Brief outlook of various genome projects – Saccharomyces Genome, C.elegans Genome and Human Genome, Comparative & Population genomics

UNIT II: INTRODUCTION TO PROTEOMICS: Protein sequencing method – Edman's degradation, Sanger Method , Protein-Protein Interaction Methods – Yeast Two hybrid analysis, Protein-DNA Interactions – DNA binding Motifs

UNIT III: FUNCTIONAL GENOMICS AND PROTEOMICS: Functional Genomics, Expression analysis – DNA microarrays , Functional proteomics - Protein chips, Protein and peptide microarray, Gene Finding ,ORF

UNIT IV: GENOMIC TOOLS: Genetic markers – RFLP, SSLP, STRs, VNTRs, Physical Markers – EST, STS, FISH, Radiation hybrids. Sequence markers – SNPs.

UNIT V: PROTEOMIC TOOLS: HPLC, PAGE, 2-D electrophoresis of proteins, LC/MS-MS for identification of proteins, MALDI-TOF , ESI

Unit VI: APPLICATIONS OF GENOMICS AND PROTEOMICS: High throughput screening in genome for drug discovery - identification of gene targets, Pharmacogenomics and drug development. Clinical and biochemical applications of proteomics

TEXT BOOKS:

1. Brown T.A, Gene Cloning, Chapman and Hall, 2004.
2. Brown T.A, Genomes, Bios Scientific Publishers Ltd 2002.
3. Greg Gibson and Spencer V. Muse, A Primer of Genome Science, 3rd Edition, Sinauer Associates, Inc., 2009

REFERENCES:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation & Genomics, 7th Edition, Blackwell, 2006.

I year - II semester M. Tech (BT)
Professional Elective-III
(7Q215) MOLECULAR DIAGNOSTICS & THERAPEUTICS

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand Lymphocyte subsets and their significance in the disease development	b,
2. Understand mediators of Immune response and their effects on the immune cells	b,
3. Understand the significance of immunological memory and its implications to infection and vaccines	c,
4. Learn techniques of Monoclonal antibody production and their application in diagnosis and therapy	e,
5. Learn about the immunotherapeutic approaches to viral and bacterial infections and cancer	e
6. Learn about the recent developments about the molecules which enhance the immune response	c

UNIT-I: ANTIGEN PRESENTATION AND MHC MOLECULES: Functioning of different APCs. MHC-restricted antigen recognition by T cells. Pathways of antigen processing. Significance of MHC-associated antigen presentation. Cross-presentation. Non-classical MHC molecules (CD1, HLA-E, F,G, MR1)

UNIT II : LYMPHOCYTE SUBSETS: Th1, Th2, Th17 subsets, regulatory T cells, alpha beta and gamma delta T cells. B lymphocyte subsets – B1 and B2 cells DC subsets.

UNIT III: IMMUNOLOGICAL MEMORY: T cells memory, B cells memory, Central & Peripheral memory. Relationship between memory and vaccines & infection.

UNIT IV: IMMUNOTECHNOLOGY: Hybridoma technology: Generation, significance and approaches of monoclonal antibody production. Immunotoxin, chemeric antibodies, humanized antibodies and bispecific antibodies. T cell cloning.Transgenics and knock-out mice. Humanized mice. Human monoclonals – B cell transformation, plasmablast separation.

UNIT V: IMMUNOTHERAPY: Cytokines, Cytoimmunotherapy, Immunomodulators in therapy, Immunotherapy of HIV infection. Natural antibodies, anti-idiotypes.

UNIT VI: ADJUVANTS: Function of adjuvants. Mechanism of action, New generation adjuvants, Plant based adjuvants.

TEXT BOOKS:

1. "Essential Immunology" by Ivan M.Roitt (1980). (Blackwell Scientific Publications, Oxford, London) fourth edition.
2. Essential Immunology – W.E. Paul

REFERENCE BOOKS:

1. Infection & immunity by John Playfair & Gregory Bancroft, 3rd edition, Oxford University press 2008.
2. "Monoclonal antibodies: Principles and practice "by J.W. Goding. Academic Press.
3. "Hybridoma Techniques: A Laboratory course" by VR. Muthukkaruppan, S. Bhaskar and F. Sinigagalia, Macmilan India Ltd.

I year - II semester M. Tech (BT) **Professional Elective-III**

(7Q216) Molecular Markers & Crop Improvement

L	T	P	C
3	1	-	3

Unit wise Course Outcomes Students will be able to	POs
1. Compare the conventional versus modern plant breeding methods	a,b,
2. Understand the types and importance of molecular markers	a,b
3. Describe application of Molecular markers in crop improvement	a,b
4. Understand the molecular biological aspects of plant processes	a,b,c
5. Understand and Explain various strategies for production of transgenic crops	a,b,c,e
6. Understand and differentiate various transgenic crop production platforms, explain the risks associated with them and safety measures to be employed	a,c,e

Unit I: Plant Biotechnology for crop improvement: Conventional plant breeding strategies, Hybridization, Inbred lines, Pure lines, Heterosis. Genetic Engineering of crops for useful agronomic traits for male sterility, food quality, improved crop productivity and molecular farming.

Unit II: Molecular markers: Random amplified polymorphic DNA (RAPD), Restriction fragment length polymorphism (RFLP), Amplified fragment length polymorphism (AFLP), Simple sequence repeats (SSR), Inter Simple sequence repeats (ISSR), Single strand conformation polymorphism (SSCP) and Quantitative trait loci (QTLs)

Unit III: Molecular markers for crop improvement: Marker assisted selection (MAS), Construction of molecular maps in plants, Map based Cloning, Molecular maps and their utility in plant genomics, Advantages and limitations of molecular markers.

Unit IV:Molecular Biology of Plant Processes: Discovery / Cloning of Plant Genes: Probe based screening, Genomic and proteomic approaches, Expressed Sequenced Tags, Developmentally regulated genes

Unit V: Transgenic Crops I: Secondary metabolites, increase in productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency, Metabolomics, post harvest technology, strategies for enhancing nutritive value of crops, introduction to male sterility for hybrid seed production

Unit VI: Transgenic Crops II: Plants as bioreactors, chloroplast transformation transgenic plants for quality improvement of protein, lipid & carbohydrate content, phytoremediation of contaminated soils, Risks and benefits of release of GM crops. Regulation of research and development of transgenic plants.

TEXT BOOKS:

1. Biochemistry & Molecular Biology of Plants (Buchanan, BB, Gruissem, W & Jones, R.L eds.) 2000
2. Molecular Plant Breeding, Yunbi Xu, CABI Publishers, I edition, 2010 (ISBN-13: **978-1845933920)**

REFERENCES

1. Principles of Plant Genetics and Breeding,George Acquaah, Blackwell-Wiley Publishers, I Edition, 2006 (ISBN-13: **978-1405136464)**
2. Plant Molecular Breeding- Sheffield Biological Series, H. John Newbury, Blackwell Publishers, 2003 (ISBN-13: **978-0849328138)**

I Year-I sem M. Tech (BT)

Professional Elective – III
(7Q217) FOOD BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Course Outcomes

1. Students shall be able to understand the principles of Food science
2. Students shall be gain knowledge and perform the methods of food preservation.
3. Students shall be able to identify the role of microbes in fermentation
4. Students shall be able to understand the role of food additives and methods to identify food adulterants
5. Students shall be understand the methods in food processing
6. Students shall be able to gain knowledge in the quality control

UNIT I: **INTRODUCTION:** Objectives of Food science and Technology, Chemical, nutritional, and functional properties of carbohydrates (starch, cellulose, sugars, pectin, fibres (changes during processing) manufacture of maltodextrins and corn syrups, Cyclodextrins, lipids (omega-3 and omega-6 fatty acids and their nutraceutical significance) Rancidity.Proteins(Protein efficiency ratioPER).

UNIT II: FOOD PRESERVATION: Principles of food preservation: Physical (Blanching, Pasteurization, Freezing), Thermal death time, D-value, Z-value , Irradiated foods –Radappertization, Radicidation, and radurization of foods. Chemical : Benzoic acid and parabens, nitrites and nitrates, phenolics, antioxidants: BHA, BHT and biological methods: Bacteriocin, Nisin)

UNIT III:FOOD MICROBIOLOGY AND **FERMENTATIONS:** Probiotics, types of microorganisms associated with food –meats, seafood, Diary products. Factors affecting growth and survival of Microorganisms in foods. Fermented meat -sausages, Fisheries - Fish Sauses, vegetables- Sauerkaraut, Olives, Dairy products -cheese, beverages- wine, beer. Spoilage in Meats, Fish, Food - borne infections – Salmonellosis, shigellosis), Food intoxications – Botulism , aflatoxins.

UNIT IV: FOOD ADDITIVES AND ANALYSIS: Pigments in food, Food Flavours and colours, Water activity measurements and its significance in food quality, Enzymatic methods of food analysis, Analysis of pesticides in foods, Analysis of heavy metals in food, analysis of phytosterols.

UNIT V: FOOD PROCESSING: Basic principles, unit operations-size reduction-hammer mill, ball mill, mixing –pan mixers ,masticators, blender. emulsification, centrifugation-tubular bowl centrifuge, disc bowl centrifuge ,Extraction, crystallization-vaccumcrystalizer.

UNIT VI: QUALITY CONTROL: Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation. International quality systems and standards like HACCP.

TEXT BOOKS

1. *Roger A., Gordan B., and John T.*, " *Food Biotechnology* ", *1989*. 3.
2. George J.B., and John T., " Food Microbiology ", CBS Publishers & Distributors, 1987. 4th edition.
3. *Frazier* and D. C. Westhoff ,*Food Microbiology*, 4th ed., 1988..

REFERENCES

1. George, J. B., "Basic Food Microbiology", CBS Publishers Distributors, 1987. 4th edition.
2. *Lindsay*, *Willis Biotechnology, Challenges for the flavor and food Industries*, *Elsevier Applied Science*, *1988*.

I year - II semester M. Tech (BT)
Open Elective
(7Q218) Biosafety& IPR

L	T	P	C
3	-	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Think ethically and to act morally to describe the legal, ethical, and emotional issues surrounding withholding and withdrawing medical therapies eg. cloning, and stem cell research	a,c, j
2. Understand the risk assessment and risk groups which includes examining laboratory containment levels & assessing containment level requirements	a,c, j
3. Understand different types of IPR and apply their knowledge in understanding Patents writing and filing..	a,c,j
4. Understand and differentiate other types of IPR	a,c,j
5. Apply their Biotechnology knowledge towards patenting skills	a,c,g, j
6. Understand various IPR laws, treaties and agreements	a,c,g, j

Unit I: Bioethics:

Principles of Bioethics. Ethics in Clinical Research: History structure regulation impact of Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF), shared responsibilities for decisions and the understanding of the risk.

Unit II: Biosafety Concepts & Regulations:

Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol, Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products. International dimensions in Biosafety. Biotechnology and food safety. Case study – Bt Cotton, Bt Brinjal

Unit III: Introduction to IPR &Patents:

Discovery, Creativity, Innovation, Invention, Need for IPR, Types of IPR, Genesis & development of IPR in India, Definition, Scope, Protection, Patentability Criteria, Types of Patents (Process, Product & Utility Models), Software Patenting. Types of searching, public & private searching Databases. Drafting & Filing of Patent applications, Patent Cooperation Treaty (PCT). Patent infringement.

Unit IV: Other Types of IPR:

Copyrights– Definition, granting, infringement, searching & filing, distinction between copy rights and related rights;Trade Marks - role in commerce, importance, protection, registration, domain names;Trade Secrets, Unfair competition; Industrial Designs – Scope, protection, filing, infringement; Semiconductors, Integrated Circuits& Layout design; Geographical Indications& Appellations of Origin; Case Studies.

Unit V: IPRs and Biotechnology:

Plant variety Protection, Farmers & Breeders Rights, Indian Biodiversity Act, Protection of Traditional Knowledge, Biopiracy & Bioprospecting, ITPGRFA, Budapest Treaty & IDA, Biotechnology Patenting issues, Gene Patenting, Case studies (Diamond vs Chakravarthy, Dimminaco AG vs. Controller of Patents, Basmati Rice, Turmeric, Neem, Harvard Oncomouse, Transgenic Plant Patents)

Unit VI: International and National Conventions& Treaties:

Overview, WTO, GATT, TRIPS, WIPO, Berne Convention, Universal Copyright Convention, the Paris Convention, Madrid Protocol, Rome convention, Budapest Treaty, Hague agreement, Locarno agreement, Indian Patents Law, Copyright Law,Trademark Law,Trade secret Law, GI Law, Designs Act.

Text Books:

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights, Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
4. N.S. Gopalakrishnan& T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

References

1. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
2. Anitha Rao R & Bhanoji Rao "Intellectual Property Rights – A Primer", Eastern Book Company, 2008.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. M. M. S. Karki , Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009
5. Neeraj Pandey &KhushdeepDharni, Intellectual Property Rights, Phi Learning Pvt. Ltd
6. AjitParulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
7. B. L. Wadehra. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
8. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

I Year-I sem M. Tech (BT)
Open Elective
(7Q219) NANOBIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. demonstrate the applications and differences between nanobiotechnology and Bionanotechnology,	a,
2. exploit the different types of spectroscopic techniques, different types of scanning probe microscopes, different types of electron microscopes, different types of lithographic techniques at nanoscale, different types of molecular synthesis techniques to at nanoscale	b,
3. Use nano level quantity of DNA and Proteins in analysis, Acquire knowledge of determining several thousands of DNA and Proteins at a single stretch, acquire knowledge of protein engineering leading to synthesis of novel proteins, Apply computational tools in analyzing protein structure and functions	c,
4. analyze applications of Photodynamic therapy in the treatment of different diseases; molecular motors in the regulation of metabolic activities; neuroelectronic interfaces in the regulation of nerve impulse and nanoluminiscent tags in the detection	e,
5. demonstrate knowledge in biopolymers; procollagen-synthesis and application, RNA Topoisomerase, Proteins acting as magnets	e,
6. demonstrate knowledge in applications of nanotechnology in agriculture, environment, food industry, Implications of nanotech on health and environment	g

UNIT I: General Principles: Definition of nano scale with reference to biosystems, Scope and future prospects, Challenges of nanotechnology., Smart Materials- Heterogenous nano structure and composites, nanoscale bio structures, Doulenano wire, Micelles and liposomes.

UNIT II: Synthesis and Characterization: Molecular synthesis, Self assembly, Polymerisation, Scanning probe instrument, spectroscopy and imaging techniques, electron microscopy, , Nanoscale lithography, e-beam lithography.

UNIT III: Molecular Nanobiology: Molecular biology of biosynthesis and molecular design, microarrays (DNA and Protein), Genetic code and protein synthesis, Hybrid Computers- Protein-hybrid computers, role of genetically engineered polymer proteins.

UNIT IV: Applications-Drug Delivery: Nanotechnology for immune system., Drugs-Photodynamic therapy, molecular motors, neuro electronic interphases, development of nanoluminiscent tags,

UNIT V: **Applications-Polymers:** Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials, nanofibers and tissue engineering.

UNIT VI: Applications of Bionanotechnology: Applications of nanotechnology in agriculture, environment and food industry.

TEXTBOOKS:

1) M. Ratner and D.Ratner, Nanotechnology –a gentle introduction to the next big idea, Pearson Education , 2007.
2) R. R. Birge, Proetin based computers, Scientific American , 1995.
3) Bionanotechnology by GoodSell-Wiley Liss.
4) Biomedical applications of nanotechnology by-Labhasetwar-Wiley Interscience.

REFERENCES:

1) L.E.Foster, Nanotechnology-Science, Innovation &opportunity , Person education inc, 2007.
2) Nanoelectronics and nanosystems-Karl Goser-Springer Engineerng Series.

I year - II semester M. Tech (BT)
Open Elective
(7Q220) Biosensors and Bioelectronics

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Learn the basic concepts in biosensing	a
2. Understand the various types of biological detectors and membranes used in Biosensors	b,f
3. Learn Principles of various types of transducers used in biosensors	b,f
4. Learn to apply various biosensors in real life situations	c
5. Learn the basic concept of nano biosensing and their application	c
6. Understand basics and applications of Molecular electronics	c,f

UNIT I: INTRODUCTION: Definition of Biosensors Advantages and limitations, various components of biosensors

UNIT II: TYPES OF BIOSENSORS: Biocatalysts based biosensors, bioaffinity based biosensors, biologically active material and analyte, Types of membranes used in biosensor constructions

UNIT III: TRANSDUCER: types, principles and applications-calorimetric, optical, potentiometric / amperometric conductrometric / resistometric, piezoelectric, bioluminescence and Chemiluminiscence - based biosensors

UNIT IV: APPLICATION OF BIOSENSORS: in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food, low cost biosensor for industrial processes on-line monitoring, biosensors for environmental monitoring

UNIT V: NANO BIOSENSORS: Nano optics for biosensors, DNA as tool for Nano bio sensing, Nanowire bio sensing. Implantable biosensors

UNIT VI: MOLECULAR ELECTRONICS: Introduction to molecular electronics, Development of molecular arrays, molecular wires and switches, mechanisms of unit assembly

TEXT BOOKS:

1. Biosensors: An Introduction by Brian R. Eggins Biosensors edited by AEG CASS OIRL press Oxford University John Wiley & Sons (1997). 2.
2. Roger, K.R. and Gerlach, C.L. 1~99. Update on environmental for biosensors. Env. Sci. Techno. 33 500A - 506A.
3. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.

REFERENCE:

1. Biosensors, Elizabeth A. H. Hall, open University Press Biotechnology Series

I year - II semester M. Tech (BT)

Open Elective

(7Q221) RENEWABLE ENERGY TECHNOLOGIES

L	T	P	C
3	-	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand different types of wind turbines, the aerodynamics of wind turbines. Also they will be able to understand the basics of design of the rotor and integration of wind energy to electrical energy along with the applications of wind energy	a, b,f
2. exploit the different types of biomass and biofuels . Also they will be understanding the applications of biomass in energy farming ,pyrolysis, anaerobic digestion.At the same time they will be knowing the basics of digester sizing and applications of biogas in various aspects.	a,b,
3. Understand solar radiation measurements and design of different types of solar radiation collectors.They will know the principles of solar cells fabrication and applications of photovoltaic cells.	a,f
4. Understand Lambert's law of absorption , heat exchanger calculations.Also they will be understanding the basics of geophysics and extraction techniques of thermal power.	a
5. Understand different categorization of fuel cells and importance of biohydrogen	a,i
6. Understand Nuclear energy principles, nuclear reactors and their safety.	a,c

Unit-I : Wind Energy – Power in wind - Availability – Types of wind turbines - Aerodynamics of Wind turbine – Momentum theory – Dynamic matching, Construction features of wind turbines - Rotor design considerations – Power extraction by a turbine – Integration of wind energy converters to electrical networks -Applications of wind energy

Unit-II : Biomass energy - Bio fuel – Conversion of biomass – Bio fuel classification- Biomass production for Energy farming- Direct combustion for heat- Pyrolysis- Thermo chemical processAnaerobic digestion- Digester sizing- waste and residues- vegetable oils and biodiesels Applications of Biogas-Social and environmental aspects

Unit-III : SOLAR ENERGY Solar radiation its measurements and prediction - solar thermal flat plate collectors concentrating collectors – applications - heating, cooling, desalination, power generation, drying, cooking etc - principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.

Unit-IV: Ocean and Geothermal Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - Heat exchanger calculations (elementary treatment) – Major problems and operational experience - Classification of geothermal resource - Fundamentals of geophysics - Availability and estimation of thermal power - Extraction techniques.

Unit-V: The Hydrogen economy – Advantages of hydrogen as an energy carrier – Components of the hydrogen economy - Generation of hydrogen - Transport and storage of hydrogen: physical and chemical - Fuel Cells – Classification of fuel cells based on (a) Type of electrolyte (b) Type of the fuel and oxidant (c) operating temperature (d) application and (e) chemical nature of electrolyte

Unit-VI: Nuclear Energy: Overview of Nuclear power plants - radioactivity - fission process- reaction rates - diffusion theory, elastic scattering and slowing down power reactors - nuclear safety. Nuclear Power Plants - Selection of Site - Nuclear Power Plants - Selection of Site - Nuclear Fuels - Nuclear reactors - Nuclear disposal

Text Books:

a. Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon

b. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
c. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
d. Solar Energy Thermal Processes,/Duffie& Beckman
e. Solar Heating and Cooling / Kreith&Kreider
f. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / Wiley
g. Wind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
h. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraw-Hill
i. Power Plant Technology / El Wakil/ Mc Graw Hill
j. Fuel cell/LivinOniciu/Abacus press 1976
k. Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 1983.

I year - II semester M. Tech(BT)

Open Elective

GENERAL MANAGEMENT &ENTREPRENEURSHIP

L	T	P	C
3	1	-	3

The objective of the course is to make students understand the nature of entrepreneurship, and to motivate the student to start his/her own enterprise with innovative skills.

Unit 1: Nature of Entrepreneurship; Characteristics, Qualities and skills of an Entrepreneur, functions of entrepreneur, Entrepreneur scenario in India and Abroad. Forms of Entrepreneurship: Small Business, Importance in Indian Economy, Types of ownership, sole trading, partnership, Joint Stock Company and other forms. First-Mover disadvantages, Risk Reduction strategies, Market scope strategy, Imitation strategies, and Managing Newness.

Unit 2: Aspects of Promotion: Generation of new entry opportunity, SWOT Analysis, Technological Competitiveness, legal regulatory systems, patents and trademarks, Intellectual Property Rights- Project Planning and Feasibility Studies- Major steps in product development.

Unit 3: Management of Small Business: Pre feasibility study - Ownership - budgeting - project profile preparation-Feasibility Report preparation - Evaluation Criteria- Market and channel selection-Product launching - Monitoring and Evaluation of Business- Effective Management ofSmall business.

Unit 4: Support Systems for Entrepreneurs: Institutional Support, Training institution, Financial Institutions and Aspects: Sources of raising Capital, Debt-Equity, Financing by Commercial Banks, Government Grants and Subsidies, Entrepreneurship Promotion Schemes of Department of Industries (DIC), KVIC, SIDBI, NABARD, NSIC, APSFC, IFCI and IDBI. New Financial Instruments.Research and Development – Marketing and legal aspects, Taxation benefits, Global aspects of Entrepreneurship.

Unit 5: Introduction to Innovation: Meaning of innovation, sources of innovative opportunity, 7 sources of innovative opportunity, Principles of innovation, the enablers of innovation, business insights, insights for innovation, technical architecture for innovation, focus on the essence of innovation.

Unit 6: Process and Strategies for Innovation: Process of innovation, the need for a conceptual approach, Factors contributing to successful technological innovation, Strategies that aim at innovation, impediments to value creation and innovation.

TEXT BOOKS:

1. Robert D Hisrich, Michael P Peters, Dean A Shepherd: Entrepreneurship, TMH, 2009
2. Peter Drucker (1993), “Innovation and Entrepreneurship”, Hyper Business Book.

I year - II semester M. Tech (BT)
Open Elective
OBJECT- ORIENTED PROGRAMMING THROUGH JAVA

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand the concept of OOP as well as the purpose and usage of principles of inheritance, Identify classes, objects, members of a class and the relationships among them needed for a specific problem.	b,
2. Understand and implement concepts of polymorphism, encapsulation and method overloading.	b,
3. Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifiers, automatic documentation through comments)	b,
4. Students understand and implement error exception handling and multi-threading.	e,
5. Students learn to create GUI and write programs for event-handling using various user interface components on applets.	c,
6. Students implement Client-server programs using Java networking packages	c

UNIT-I: History of Java, Java buzzwords, datatypes, variables, simple java program,scope and life time of variables,operators, expressions, control statements, type conversion and costing, arrays,, classes and objects – concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, recursion, string handling, StringTokenizer.

UNIT-II: Inheritance –Definition ,single inheritance , benefits of inheritance, Member access rules, super class, polymorphism- method overriding, Dynamic method dispatch, using final with inheritance, abstract classes,Base class object.

UNIT-III: Interfaces :definition, variables and methods in interfaces , differences between classes and interfaces, usage of implements and extends keyword, an application using interfaces, uses of interfaces. Packages: Definition, types of packages, Creating and importing a user defined package.Introduction to i/o programming: DataInputStream, DataOutputStream, FileInputStream, FileOutputStream, BufferedReader.

UNIT-IV: Exception handling -exception definition, benefits of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes.Multi-Threading:-Thread definition, types of multitasking, uses of multitasking, ,thread life cycle, creating threads using Thread class and Runnable interface, synchronizing threads, daemon thread.

UNIT-V: Advantages of GUI over CUI ,The AWT class hierarchy,Component,Frame,user interface components- labels, button, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, menubar, graphics, layout, managers –boarder, grid, flow, card and grid bag.Event handling: Delegation event model,closing a Frame,mouse and keyboard events, Adapter classes.

UNIT-VI: Applets – Concepts of Applets, differences between applets and applications,life cycle of an applet, types of applets, creating applets, passing parameters to applets.Networking – Basics of network programming, addresses, ports, sockets, simple client server program,multiple clients, sending file from server to client.

TEXT BOOKS

1. Java; the complete reference, 6th editon, Herbert schildt, TMH.
2. Introduction to Java programming 6th edition, Y. Daniel Liang, pearson education.

REFERENCES

1. Core Java 2, Vol 1, Fundamentals, Cay.S.Horstmann and Gary Cornell, seventh Edition, Pearson Education.
2. Core Java 2, Vol 2, Advanced Features, Cay.S.Horstmann and Gary Cornell,Seventh Edition, Pearson Education

I year - II semester M. Tech (BT)
(7Q275) COMPREHENSIVE VIVA-VOCE -II

L	T	P	C
-	-	-	1

Course Out Comes:

1. Students will be able to develop ability to recapitulate Biotechnology concepts and reproduce them orally.

2.The main aim of Comprehensive Viva-Voce is to assess the students understanding in various subjects he / she studied during the M. Tech. Biotechnology course of study.

There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the students' understanding in various subjects he/she studied during the M.Tech course of study. The Comprehensive Viva-Voce is valued for 50 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce. A candidate has to secure a minimum of 50% to be declared successful.

I year - II semester M. Tech(BT)

(7Q276) BIOPROCESS ENGINEERING LAB

L	T	P	C
-	-	4	2

Experiment wise Course Outcomes	POs
Student will be able to	
1. operate Bioreactor in different batch, fed batch modes,	b,c,d
2. Understand Bioprocesses for the production of Citric acid & Ethanol	b,c,d
3. explain kinetics of enzyme catalysed reactions	b,c,d
4. Understand volumetric mass transfer coefficients	b,c,d
5. Immobilize whole cells and enzymes	b,c,d
6. Explain calculation of Power number Correlations	b,c,d

1. Immobilization of whole cells (Yeast)
2. Immobilization of enzymes (amylase).
3. Various bioprocesses followed by product recovery e.g.
   (i) Citric acid production from *A. niger*
   (ii) Ethanol production from *S. cereviceae*

4. Enzyme kinetic studies: Determination of michaelismenten constant
5. Microbial kinetic studies: determination of monods model constants
6. Determination of volumetric mass transfer coefficient sodium sulphate oxidation method
7. Calculations for power number correlations
8. Experiments on Bioreactor operation
   a. Screening
   b. Media preparation for fermentation
   c. Fermenter testing
   d. pH probe calibration
   e. D.O. probe calibration
   f. D.O. probe calibration
   g. Pump calibration
   h. Fermenter sterilization
   i. Fermenter charging
   j. Media sterilization
   k. Inoculation methods for fermenter
   l. Fermentation-Batch, Fed Batch
   m. Addition bottles: solution preparation
   n. Sampling
   o. Harvest the culture from the fermentor

I year - II semester M. Tech(BT)

(7Q277) LITERATURE REVIEW AND TECHNICAL SEMINAR-2

L	T	P	C
-	-	3	1

Course Outcomes	POs
Students will develop ability to	
1. Identify a research topic,	a,i
2. Collect literature	d,i
3. Write technical review paper	c,d,h,i,k
4. Present seminar	d,h,i,k
5. Discuss the queries and	d,h,k
6. Publish research paper	d,h,i,k

Course Out Comes :

The student will be able to select a specialized topic, perform literature survey on the topic an prepare technical report in their area.

There shall be one seminar presentations during I year II Semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a advanced topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental ReviewCommittee(DRC), which shall consist of the Head of the Department, a senior Faculty Member and the Supervisor and will jointly evaluate the report and presentation.There will be only internal evaluation of 25 marks. A candidate has to secure a minimum of 50% to be declared successful.

The seminar the report must be in the form of the review paper of IEEE / ASME etc. The Technical Seminar in the form of Independent Review Paper must be of high quality fit for publication in a reputed journal.

The evaluation format for seminar is as follows:

- Day to day evaluation by the Supervisor : 5 marks
- Final Report : 5 marks
- Presentation : 15 marks

I year - II semester M. Tech(BT)
(7Q278) PROJECT SEMINAR-I(Abstract)

L	T	P	C
-	-	3	2

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

Course Out Comes :

Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.

In I year II semester, a project seminar shall be conducted for 25 marks and for 2 credits (there is no external evaluation). At this stage student is to identify the Title of the Main project work which is to be carried out in II year. The exhaust literature survey is to be carried out . The evaluation for the project seminar shall be done in two stages, i.e. in the middle of the semester and at the end of the semester. The mid-semester seminar evaluation shall carry 10 marks and the end semester seminar evaluation shall carry 15 marks. The report for the mid-semester project seminar will carry 5 marks and remaining 5 marks shall be for presentation and discussion. The report for end semester project seminar shall be for 10 marks and the remaining 5 marks shall be for presentation and discussion. A candidate shall secure a minimum of 50% to be declared successful.

II year – I semester M. Tech(BT)

(7Q379) Project seminar - II

L	T	P	C
-	-	-	4

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

Course Out Comes :

The student will be able to select a specialized topic, collect information on the topic andprepare technical report in their area.

A project seminar shall be conducted for 50 marks and for 2 credits (there is no external evaluation). At this stage the progress of the project will be reviewed. The main focus will be on the critical Literature review and the design part of the work will be assessed. The evaluation for the project seminar shall be done in two stages, i.e. in the middle of the semester and at the end of the semester. The mid-semester seminar evaluation shall carry 20 marks and the end semester seminar evaluation shall carry 30 marks. The report for the mid-semester project seminar will carry 5 marks and remaining marks shall be for presentation and discussion. The report for end semester project seminar shall be for 10 marks and the remaining marks shall be for presentation and discussion. A candidate shall secure a minimum of 50% to be declared successful.

II year – I semester M. Tech(BT)

(7Q380) Project work (Part – I)

L	T	P	C
-	-	-	20

Course Outcomes	POs
Students will be able to develop Ability to perform interdisciplinary research projects, write Dissertation report and effective presentation of research results.	a,b,c,d,e,f ,g,h,i,j,k

A candidate is permitted to submit Project Dissertation only after successful completion of PG subjects (theory and practical), seminars, Comprehensive viva-voce, PG Project Part–I, and after the approval of PRC, not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and shall make an oral presentation before the PRC. Along with the draft thesis the candidate shall submit draft copy of a paper in standard format fit for publication in Journal / Conference, based on the project thesis, to the Head of the Department with due recommendation of the supervisor.

- Five copies of the Project Dissertation certified by the Supervisor and Head of the Department shall be submitted to the College.

- The dissertation shall be adjudicated by one examiner selected by the College. For this, Head of Department shall submit a panel of 3 examiners, who are eminent in that field, with the help of the PRC. The Chief Superintendent of the college in consultation with the college academic committee shall nominate the examiner.

- If the report of the examiner is not favorable, the candidate shall revise and resubmit the Dissertation, in the time frame as prescribed by PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate can re-register only once for conduct of project and evaluation of Dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.

- If the report of the examiner is favorable, viva-voce examination shall be conducted by a Board consisting of the Head of the Department, Supervisor and the Examiner who adjudicated the Dissertation. The Board shall jointly report the student's performance in the project work as – (a) Excellent, or (b) Good, or (c) Satisfactory, or (d) Unsatisfactory, as the case may be. In case, the student fails in the viva-voce examination, or gets the Unsatisfactory grade, he can re-appear only once for the viva-voce examination, as per the recommendations of the Board. If he fails at the second viva-voce examination, the candidate can re-register only once for conduct of project and evaluation of Dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.

II year – II semester M. Tech(BT)

(7Q481) Project seminar - IV

L	T	P	C
-	-	-	2

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

Project seminar-IV shall be conducted for 50 marks and for 2 credits (there is no external evaluation). At this stage the continuous progress of the project will be reviewed. The main focus will be on the simulation studies and the experimental studies be assessed. The evaluation for the project seminar shall be done in two stages, i.e. in the middle of the semester and at the end of the semester. The mid-semester seminar evaluation shall carry 20 marks and the end semester seminar evaluation shall carry 30 marks. The report for the mid-semester project seminar will carry 5 marks and remaining marks shall be for presentation and discussion. The report for end semester project seminar shall be for 10 marks and the remaining marks shall be for presentation and discussion. A candidate shall secure a minimum of 50% to be declared successful.

II year – II semester M. Tech (BT)

(7Q482) Pre Submission & Project seminar (Final)

L	T	P	C
-	-	-	2

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

Pre Submission Project seminar-V shall be conducted for 50 marks and for 2 credits (there is no external evaluation). At this stage the quality of overall project work will be reviewed by DRC and committee members will submit a report to the H.O.D. According to the Report, the candidate will submit his/her project . The report for project seminar shall be for 20 marks and the remaining marks shall be for presentation and discussion. A candidate shall secure a minimum of 50% to be declared successful.

II year – IIsemester M. Tech(BT)
(7Q483) Project work and Dissertation

L	T	P	C
-	-	-	20

Course Outcomes	POs
Students will be able to develop Ability to perform interdisciplinary research projects, write Dissertation report and effective presentation of research results.	a,b,c,d,e,f, g,h,i,j,k

A candidate is permitted to submit Project Dissertation only after successful completion of PG subjects (theory and practical), seminars, Comprehensive viva-voce, PG Project Part–I, and after the approval of PRC, not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and shall make an oral presentation before the PRC. Along with the draft thesis the candidate shall submit draft copy of a paper in standard format fit for publication in Journal / Conference, based on the project thesis, to the Head of the Department with due recommendation of the supervisor.

- Five copies of the Project Dissertation certified by the Supervisor and Head of the Department shall be submitted to the College.
- The dissertation shall be adjudicated by one examiner selected by the College. For this, Head of Department shall submit a panel of 3 examiners, who are eminent in that field, with the help of the PRC. The Chief Superintendent of the college in consultation with the college academic committee shall nominate the examiner.
- If the report of the examiner is not favorable, the candidate shall revise and resubmit the Dissertation, in the time frame as prescribed by PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate can re-register only once for conduct of project and evaluation of Dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.

If the report of the examiner is favorable, viva-voce examination shall be conducted by a Board consisting of the Head of the Department, Supervisor and the Examiner who adjudicated the Dissertation. The Board shall jointly report the student's performance in the project work as – (a) Excellent, or (b) Good, or (c) Satisfactory, or (d) Unsatisfactory, as the case may be. In case, the student fails in the viva-voce examination, or gets the Unsatisfactory grade, he can re-appear only once for the viva-voce examination, as per the recommendations of the Board. If he fails at the second viva-voce examination, the candidate can re-register only once for conduct of project and evaluation of Dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.