VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination2018-19
M.Tech inBiotechnology(BBT)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18BBT11	Numerical Methods & Biostatistics	04	--	03	40	60	100	4
2	PCC	18BBT12	Concepts in Biotechnology	04	--	03	40	60	100	4
3	PCC	18BBT13	Principles of Biochemical Engineering	04	--	03	40	60	100	4
4	PCC	18BBT14	Biomolecules and Molecular Biology	04	--	03	40	60	100	4
5	PEC	18XXX15X	Professional Elective-1	04	--	03	40	60	100	4
6	PCC	18BBTL16	Chemical Engineering & Molecular Biology Lab	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core; PEC: Professional Elective

Professional Elective 1

Course Code under 18XXX15X	Course title
18BBT151	Analytical Techniques
18BBT152	Enzyme Technology
18BBT153	Genetic Engineering Techniques

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted forth same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying
The internship requirements.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18BBT21	Industrial Biotechnology	04	--	03	40	60	100	4
2	PCC	18BBT22	Advanced Bioinformatics	04	--	03	40	60	100	4
3	PCC	18BBT23	Agricultural Biotechnology	04	--	03	40	60	100	4
4	PEC	18BBT24X	Professional Elective 2	04	--	03	40	60	100	4
5	PEC	18XXX25X	Professional Elective 3	04	--	03	40	60	100	4
6	PCC	**18BBTL26**	**Industrial BiotechnologyLab**	--	04	03	40	60	100	2
7	PCC	18BBT27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 2		**Professional Elective 3**	
Course Code under 18XXX24X	**Course title**	**Course Code under 18XXX25X**	**Course title**
18BBT241	Systems Biology	18BBT251	Food Biotechnology
18BBT242	Immunotechnology	18BBT252	Clinical Biotechnology
18BBT243	Industrial Economics	18BBT253	Pharmaceutical Biotechnology

Note:

1. Technical Seminar: CIE marks shall beawarded by a committeecomprising of HoD as Chairman, Guide/co- guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory. The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship hallbedeclaredasfailedandhavetocompleteduringthesubsequentUniversityexaminationaftersatisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18BBT31	Biosafety And Bioethics	04	--	03	40	60	100	4
2	PCC	18BBT32	Environmental Biotechnology	04	--	03	40	60	100	4
3	PEC	18XXX33X	Professional Elective 4	04	--	03	40	60	100	4
4	Project	18BBT34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Internship	18BBTI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and IIIsemesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 4

Course Code under 18XXX33X	Course title
18BBT331	Project Management
18BBT332	QC, QA & Validation
18BBT333	Entrepreneur Development

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship, shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements. Internship SEE (Universityexamination)shallbeaspertheUniversitynorms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18BBT41	Project work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2 shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

M.Tech-BIOTECHNOLOGY

M.Tech FIRST SEMESTER SYLLABUS

NUMERICAL METHODS & BIOSTATISTICS [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I			
Course Code	**18BBT11**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enables the students

- To develop skills towards the design & analysis of statistical experiments
- Use appropriate numerical and statistical methods to analyze and interpret data
- Demonstrate effective use of these tools in problem solving and analysis

Modules	**Revised Bloom's Taxonomy(RBT) Level**
Module -1	
Introduction to statistics and study design: Introduction tostatistics, data, variables, types of data, tabular, graphical andpictorial representation of data. Significance of statistics tobiological problems, experimental studies; randomized controlled studies, historically controlled studies, cross over,factorial design, cluster design, randomized; complete, block,stratified design, biases, analysis and interpretation	**L1,L2**
Module -2	
Descriptive statistics and Observational study design: Typesof variables, measure of spread, logarithmic transformations,multivariate data. Basics of study design, cohort studies, casecontrolstudies, outcomes, odd ratio and relative risks.Principles of statistical inference: Parameter estimation,hypothesis testing. Statistical inference on categoricalvariables; categorical data, binomial distribution, normaldistribution, sample size estimation	**L1,L2**
Module -3	
Comparison of means: Test statistics; t-test, F distribution,independent and dependentsample comparison, WilcoxonSigned Rank Test, Wilcoxon Mann-Whitney Test, ANOVA.Correlation and simple linear regression: Introduction, KarlPearson correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, regression model fit,inferences from the regression model, ANOVA tables forregression. **Multiple linear regression and linear models:** Introduction, Multiple linear regression model, ANOVA tablefor multiple linear regression model, assessing model fit,polynomials and interactions. One-way and Two-way ANOVA tables, F-tests. Algorithm and implementation usingnumerical methods with case studies	**L1,L2**
Module -4	

Design and analysis of experiments: Random block design,multiple sources of variation, correlated data and randomeffects regression, model fitting. Completely randomizeddesign, stratified design. Biological study designs.Optimization strategies with case studies.	**L3, L4, L5**
MODULE – 5	
Statistics in microarray, genome mapping and bioinformatics: Types of microarray, objectives of the study, experimentaldesigns for micro array studies, microarray analysis,interpretation, validation and microarray informatics. Genome mapping, discrete sequence matching, programs formapping sequences with case studies.	**L3, L4, L5**

Course outcomes: After studying this course, students will be able to:

• Demonstrate strong basics in statistics and numerical analysis,

• foundation to tackle live problems in various spheres of bioscience and bioengineering

• Study and design various statistical problems

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Alvin E. Lewis, Biostatistics, McGraw-Hill Professional Publishing, 2013.
2. J.D. Lee and T.D. Lee. Statistics and Numerical Methods in BASIC for Biologists,VanNostrand Reinhold Company, 1982.
3. T.P. Chapman, Statistical Analysis of Gene Expression Microarray Data, CRC, 2003.

REFERENCE BOOKS

1. Wolfgang Boehm and HartmutPrautzsch, Numerical Methods, CRC Press, 1993.
2. John F. Monahan. Numerical Methods of Statistics (Cambridge Series in Statistical
1. and Probabilistic Mathematics), Cambridge University Press, 2011.
2. Joe D. Hoffman. Numerical Methods for Engineers and Scientists, CRC Press, 2nd
3. Edition, 2001.
4. Warren J. Ewens Gregory Grant, Statistical Methods in Bioinformatics: An
5. Introduction (Statistics for Biology and Health), Springer, 2005

CONCEPTS IN BIOTECHNOLOGY

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER – I

Course Code	**18BBT12**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: The course will enables the student:

- Appreciate the Basic concepts and apply the knowledge to Biotechnological problems
- Use these skills towards the design & analysis of life science experiments
- Demonstrate effective use of these tools and techniques in solving problems relevantfor society.

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION TO BIOLOGY: Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: DNA & RNA; storage and transfer of genetic information; Lipids: membranes, structure & function; Carbohydrate chemistry, energy storage, building blocks.	**L1,L2, L3**
Module -2	
CELL STRUCTURE: Eukaryotic and Prokaryotic cells, plant and animal cells, structure of nucleus, mitochondria, ribosomes, Golgi bodies, lysosomes, endoplasmic reticulum, chloroplast, vacuoles; Cell cycle and cell division: Different phases of cell cycle, cell division: Mitosis and meiosis. Mendelian law of inheritance: Monohybrid and dihybrid inheritance, law of segregation and independent assortment; Gene Interaction; Multiple alleles, supplementary and complementary genes, epistasis. Identification of genetic material: classical experiments; chromosome structure and organization, chemical composition of chromatin, structural organization of nucleosomes, heterochromatin, polytene and lamp-brush chromosomes, human chromosomes, chromosomal disorders.	**L1,L2**
Module -3	
SCOPE AND HISTORY OF MICROBIOLOGY, INTRODUCTION TO THE STRUCTURE AND FUNCTIONS OF MICROORGANISM: Bacteria, Viruses, Fungi and Protozoan's. Microscopy and microbial techniques: Study of microscopes; sterilization techniques: Heat, steam, Radiation, Filtration and chemical methods; Pure culture techniques: Serial Dilution, Streak, Spread, Pour Plate. Immune System, Innate and adaptive immunity, antigens and antibodies;and interactions. One-way and Two-way ANOVA tables, F- tests. Algorithm and implementation using numerical methods with case studies types of immune response, hypersensitivity. Humoral immunity: B-lymphocytes, Immunoglobulin classes, Major Histocompatibility Complex (MHC). Cell mediated immunity. Thymus derived lymphocytes (Tcells), Antigen presenting cells (APC); Immunity to infection, Cytokines.	**L1,L2,L3, L4**
Module -4	

SCOPE OF AGRICULTURAL BIOTECHNOLOGY: Role of Micorbes in agriculture, Biopesticides, Bio fertilizers (Nitrogen fixing microbes), GM crops. Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics, antibodies, edible vaccines. Metabolic engineering of plants for the Production of fatty acids, industrial oils, flavonoids etc. Basic aspects of Food & Nutrition.	**L3, L4, L5, L6**
MODULE – 5	
Industrially important Microorganisms, Preservation techniques, Different media for fermentation, basic structure of fermentor and different types. Types of fermentation processes (surface, submerged, and solid state) and their products (ethanol, citric acid, lactic acid, enzymes, antibiotics) Biological treatment of waste water, primary, secondary and tertiary treatments. Bio indicators, Bioremediation of xenobiotic compounds, Bioleaching of minerals from ores, Bio-sorption of toxic metals. Solid waste management. Biofuel production from agricultural wastes.	**L3, L4, L5, L6**

Course outcomes: After studying this course, students will be able to:

- Demonstrate strong basics in principles of biotechnology.
- Demonstrate strong basics in biotechnology and numerical analysis

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. De Robertis EDP and De Robertis Jr. EMF, Cell and Molecular Biology, Wippincott Williams and Wiilkins publisher, 2001.
2. Strickburger M W, Principles of Genetics, 3rd edition, Prentice Hall Publication, India, 2011.
3. Prescott and Dunn, Industrial Microbiology, Macmillian, 1982.
4. Ashim K Chakravarthy, Immunology &Immunotechnology, Oxford University Press, 2006.

REFERENCE BOOKS

1. Gardner, Simmonns and Snustad, Principles of Genetics, 8th edition, 2005.
2. P S Verma, V R Agarwal, Cell Biology, Genetics, Evolution and Ecology, NewPublisher Delhi, 2007.
3. K. Lindsey and M.G.K. Jones, Plant biotechnology in Agriculture, Prentice hall, NewJersey. 1989.
4. Munnecke DM, Johnson LM and others, Biodegradation and Detoxification of Environmental Pollutants CRC Press, 1982

PRINCIPLES OF BIOCHEMICAL ENGINEERING

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER – I

Course Code	**18BBT13**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: The course will enable the students

- Analyze chemical and biochemical systems, their principles using thermodynamic fundamentals.
- Perform feasibility studies on chemical engineering processes along with fluid flow system.
- Acquire knowledge for heat and mass transfer systems employed in industrial processes.

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
Energy and Material Balances: Material Balance: Law conservation of mass, Materialbalance with and without reactions. Energy Balance: Law of conversation of energy, Energybalance with and without chemical reactions. Introduction to Momentum Transfer: Types of fluids:Newtonian and Non Newtonian fluids.Measurement of viscosity, Laminar and Turbulent flow,eddy viscosity, flow of a fluid past a solid surface (Cellsand immobilized systems), motion of particles in fluid(centrifugation & sedimentation), flow of fluid through granular bed (packed column), fluidization andbubble column	**L1,L2, L3**
MODULE -2	
Concepts of Heat and Mass Transfer: Heat Transfer: Thermal conductivity and mechanism of energy transport, design principles of heat exchangers,measurement of heat transfer coefficient, principles,construction and application of evaporators and dryers. Mass transfer: Diffusion and its types, measurement ofdiffusivities, theoretical estimation of diffusitivities,interfacial diffusion (Mass transfer), convective masstransfer, measurement of mass transfer coefficient, Masstransfer process (Principle, construction and applicationof Distillation, adsorption, extraction andcrystallization).	**L1,L2,L3**
MODULE -3	
Thermodynamics and Bioenergetics Thermodynamics: First and Second law ofthermodynamics, application of first and second law inBiomolecular structure, PVT behaviour, PVT diagramof pure fluids, thermodynamics models used in processindustries (Peng-Robinson model, EOS, NRTL,SRKetc). Properties of solution, phase equilibrium. Chemicalpotential and activity of molecules, statisticalthermodynamics, Bioenergetics: Energetic of metabolicpathways, energy coupling, thermodynamic efficiencyof growth and yield co-efficients	**L1,L2,L3, L4**
Module -4	

Reaction Engineering: Kinetics of enzyme catalyzed reactions, kinetics of microbial growth, substrate utilization and productformation. Batch and continuous reactors, energy andmass balance in biological reactions. Heterogeneousreaction: Shell balance (Immobilized system), effect ofmass transfer on reaction, Thiele modulus, solid liquidmass transfer correlations, minimizing mass transfereffects	**L3, L4, L5, L6**
MODULE – 5	
DRYING &RTD IN REACTORS: Drying; moisture content and its types, wet and drymoisture contents, drying curve, drying equipments,RTD curves-its interpretation, RTD for CSTR and PFRcalculations.	**L3, L4, L5, L6**

Course outcomes: At the end of the course the graduates should be able to:

- Derive and calculate thermodynamic relations using energy equations.
- Analyze the kinetics related to enzyme catalyzed reactions

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Stoichiometry by Bhatt B. I and S.M. Vora ,Tata McGraw Hill, 4th Edition, 2004.
2. Unit operations of Chemical Engineering by McCAbe RL & J.C Smith, McGraw Hill International Editions, 2001.
3. Mass Transfer Operations by Robert E. Treybal. McGraw-Hill Education.
4. Introduction to Chemical Engineering thermodynamics by Smith &Vanness, MGH.

REFERENCE BOOKS

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Edition, John Wiley, 1999.
2. Bailey J.E. and Ollis D.F. Biochemical Engineering Fundamentals 2nd Edition, McGraw- Hill Book CO., Singapore, (1986).
3. Michael Shuler and FikretKargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, PHI, 2002.
4. Pauline Doran, Bioprocess Engineering Principles,1st Edition, Academic Press, 1995.

BIOMOLECULES AND MOLECULAR BIOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I			
Course Code	**18BBT14**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To portray the properties and metabolism associated with biomolecules.
- □To enlighten on transcription, translation, and regulation of gene expression in prokaryotes and eukaryotes

Modules	Revised Bloom's Taxonomy(RBT) Level
MODULE -1	
INTRODUCTION TO MACROMOLECULES: Biomolecules; Nucleic acids: storage and transfer of genetic information; Carbohydrates: energy transactions and structural blocks Proteins: structure, folding and catalysis; Lipids: membranes and energy transactions; Nucleic Acids: Structure of DNA, Alternative forms of DNA - A, B, Z and triplex DNA. Melting Curve ofDNA double helix, Hyperchromoic effect and factorsresponsible for DNA double helical structure, Structure of RNA and Structural aspects of mRNA, tRNA andrRNA. Composition and primary structure of proteins;Conformational analysis and forces that determineprotein structures and geometries; potential energycalculations, phi, psi, omega angles, Ramachandran orsteric contour diagram, chi angles of side chains inproteins; hydrogen bonding; disulphide bonds;hydrophobic interactions; alpha helices; beta sheets;helix to coil transition, general features andthermodynamic aspects of protein folding and foldingkinetics, protein-ligand interactions.	**L1,L2, L3**
MODULE -2	
REPLICATION, REPAIR AND RECOMBINATION: Mode of DNA Replication, basic Requirements for DNA Synthesis, Steps involved in DNA synthesis, Origin of replication in Prokaryotes and Eukaryotes. Replication initiation, elongation and termination in prokaryotes and eukaryotes; Repliosome and Replication Fork, Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA – Mitochondrial and Chloroplast DNA. DNA damage and DNA repair, DNA repair mechanisms - Photoreactivation; Nucleotide excision repair; Mismatch correction; Post replication repair and SOS repair; Recombination: Homologous and non-homologous; Site specific recombination.	**L1,L2,L3**
MODULE -3	
BASIC FEATURES OF RNA SYNTHESIS AND STEPS INVOLVED IN TRANSCRIPTION, PROKARYOTIC & EUKARYOTIC RNA POLYMERASES: Prokaryotic Transcription and regulation; Transcription unit, Promoters and Transcription process, Initiation; Attenuation; Termination: Rho-dependent and independent; Antitermination. Transcriptional control in lambda phage; Eukaryotic	**L1,L2,L3, L4**

transcription and regulation;RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA box binding protein (TBP) and TBP associated factors (TAF); Activators and repressors; Transcript processing;Processing of tRNA and rRNA.	
MODULE -4	
GENE REGULATION AND OPERON CONCEPT: Constitutive, Inducible and Repressible systems; Operators and Regulatory elements; Positive and negative regulation of operon; lac, trp, ara, his, and gal operons and their regulation; Transcriptional and post-transcriptional gene silencing. Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. ; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/ Lox recombination.	**L3, L4, L5, L6**
MODULE – 5	
TRANSLATION AND PROTEIN TARGETING: Requirements for protein biosynthesis, Steps involved in protein biosynthesis, Ribosomes; Composition and assembly; Genetic code; Evolution of Triplet concept, Properties of genetic code. tRNA and its role in translation; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic codon variation in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation.	**L3, L4, L5, L6**
Course outcomes: At the end of the course the graduates should be able to: Develop a profound foundation in fundamental of biochemical concepts. Explain the expression, regulation, manipulation, of genes and genetic manipulation techniques in the living cells at transcriptional and post transcriptional level.	
Question paper pattern: • Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks. • Eachfullquestioncanhaveamaximumof4subquestions. • There will be 2 full questions from each module covering all the topics of the module. • Students will have to answer 5 full questions, selecting one full question from eachmodule. • The total marks will be proportionally reduced to 60 marks as SEE marks is 60.	
TEXT BOOKS 1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; 2. Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc,2007.	
REFERENCE BOOKS 1. Charles R. Cantor, Paul R. Schimmel, Biophysical Chemistry. W.H.Freeman, 1980. 2. G P Jeyanthi, Molecular Biology, MJP Publishers Chennai 2009. 3. Veer balRastogi, Fundamentals of Molecular biology,Ane's Publication New Delhi 2011 . 4. John Kurian , The Molecules of Life , Garland Science , 2012	

Professional Elective 1

ANALYTICAL TECHNIQUES [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I			
Course Code	**18BBT151**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To develop technical skills of all basic biochemical and biophysical techniques.
- To use appropriate analytical methods and to critically review the experimental observations.
- To inculcate the ability to design & conduct case-specific experiments, and analyze the results.

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
BRIEF REVIEW OF ELECTROMAGNETIC SPECTRUM AND ABSORPTION OF RADIATIONS: Theory of spectroscopy, absorption of organic molecules, choice of solvent and solvent effects,modern instrumentation – design and working principle.Applications of UV-Visible spectroscopy (qualitative andquantitative analysis). Principles of vibrationalspectroscopy, frequency and factors influencingvibrational frequency, instrumentation and samplingtechniques, interpretation of spectra, applications inbiology. FT-IR-theory and applications, Attenuated TotalReflectance (ATR). Raman Spectroscopy, theory,instrumentation, and applications to biology. Discussionswith Case studies.	**L1,L2, L3**
MODULE -2	
FUNDAMENTAL PRINCIPLES OF NMR: Instrumentation, solvents, chemical shift, and factorsaffecting chemical shift, spin-spin coupling, couplingconstant, and factors influencing the value of couplingconstant, spin-spin decoupling, proton exchangereactions, FT-NMR, 2D -NMR, NMDR, NOE, NOESY, COSY and applications in Pharmacy, interpretation ofspectra, C13 NMRIntroduction, Natural abundance, C13NMR Spectra and its structural applications. Discussionswith Case studies	**L2,L3,L4, L5**
MODULE -3	
BASIC PRINCIPLES AND INSTRUMENTATION OF ION FORMATION AND TYPES: Fragmentationprocesses and fragmentation pattern, Chemical ionizationmass spectroscopy (CIMS), Field Ionization MassSpectrometry (FIMS), Fast Atom Bombardment MS(FAB MS), Matrix Assisted laser desorption / ionizationMS (MALDI-MS), GC-MS. LC-MS. MS-MS.Discussions with Case studies.	**L2, L3,L4, L5**
MODULE -4	
INTRODUCTION TO X-RAY: Generation of X-rays, X-ray diffraction, Bragg's law, X-ray powder diffraction, interpretation of diffraction patterns and applications. Single crystal diffractions of biolomolecules. Fibre diffraction. Neutron diffraction. XAFS. ORD Principle, Plain curves, curves with cotton effect, octant rule and its applications with example, circular dichroism and its relation to ORD. Discussions with Case studies.	**L2, L3, L4, L5**

MODULE – 5

CHROMATOGRAFIC TECHNIQUES: Classification of chromatographic methods based on mechanism of separation: paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography and affinity chromatography – techniques and applications. Gas Chromatography: Theory and principle, column operation, instrumentation, derivatisation methods and applications. HPLC, LC-MS and applications in HPTLC. Discussions with Case studies	**L2, L3, L4, L5**

Course outcomes: At the end of the course the graduates should be able to:

- Demonstrate strong basics in principles of Analytical techniques
- Tackle live problems in various spheres of biological sciences.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Fundamentals of Bioanalytical Techniques and Instrumentation, SabariGoshal& A K Shrivastava, PHI, 2009.
2. Donglas A. Skoog, James, J. Leary, Principles of Instrumental Analysis by, 4th Edition. 1992.
3. George T. Tsao, Philip M. Boyer Chromatography, Springer-Verlag, 1993
4. James W. Munson, Pharmaceutical Analysis – Moder n Methods, Taylor & Francis, 2001

REFERENCE BOOKS

1. H. Beckett & J. B. Stenlake, Practical Pharmaceutical Chemistry, 4th Edition, 1988.
2. K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publishing House Meerut 9th Edition, 2000.
3. SarojDua&NeeraGarg, Biochemical Methods of Analysis, Alpha Science, 2010.
4. Robert. M. Silverstein, Spectrometric identification of Organic Compounds, 7th Edition, 1981.

ENZYME TECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I			
Course Code	**18BBT152**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- Conceptualize for product separation techniques from biological source and their utility in various industries.
- Principles and techniques involved in kinetics and immobilization of enzymes

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION, CURRENT AND POTENTIAL USES OF ENZYME TECHNOLOGY: Enzymes as biocatalysts: advantages and disadvantages over chemical catalysts and characteristics.Extraction and Purification of Enzymes: Extraction ofenzymes: Extraction of soluble enzymes and membrane boundenzymes, nature of extraction medium andconditions of extraction. Purification of enzymes:preliminary and secondary purification procedures,degree of purification and criteria of purity of enzymes.Determination of molecular mass of enzymes.	**L1,L2, L3**
MODULE -2	
ENZYMATIC TECHNIQUES: Principles of enzymatic analysis. End-point and kinetic methods, immunoassays, spectrophotometric, electrochemical and radiochemical. Test strips methods, automation in enzymatic analysis: fixed time, fixed and continuous concentration. Handling of enzymes and coenzymes. Applications of enzymes in medicine and diagnostic kits; therapeutic enzymes.	**L1, L2,L3,L4**
MODULE -3	
INDUSTRIAL APPLICATIONS OF ENZYME TECHNOLOGY: Textile industry, detergents, pulp and paper, leather, wood, animal feed, food and dairy industry - amylases, proteases, lipases, pectinases. Immobilization of Enzymes: Introduction, immobilization techniques and carriers. Immobilization techniques for soluble and insoluble (bound) enzymes. Immobilization of cells and organelles. Activity and kinetics of immobilized enzymes.	**L1,L2,L3**
MODULE -4	
IMMOBILIZED ENZYME REACTORS: Types of bioreactors: Batch stirred tank, plug-flow tubular, continuous stirred tank, fixed (packed) bed, fluidized bed and membrane. Applications Of Immobilized Enzymes: Enzyme sensors for clinical analysis, therapeutic medicine (intracorporeal and extracorporeal applications). Production of highfructose corn syrup, L-aspartic acid, L-alanine and acrylamide. Environmental applications. Economic aspects of immobilized enzymes, microorganisms, mammalian cells and plant cells. Safety aspects.	**L1, L2, L3, L4**

MODULE – 5

ENZYME ENGINEERING: Glucose isomerase, subtilisin, redesigned lactate dehydrogenase. Synthetic enzymesperoxidase. Catalytic antibodies	**L3, L4, L5**

Course outcomes: At the end of the course the graduates should be able to:

- Utilize the principles of enzyme purification and the product in various industries.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Klaus Buchholz, Volker Kasche and Uwe Theo Bornscheuer. Biocatalisys and
2. Enzyme Technology. 1st edn. Wiley-VCH, 2005.
3. Wolfgang Aehle. Enzymes in industry-production and applications. 3rd edn. Wiley- VCH, 2007.
4. Chaplin M.F. and C. Bucke. Enzyme Technology. CUP. Cambridge. 1990.

REFERENCE BOOKS

1. Price N. C. and L Stevens. Fundaments of Enzymology: 3rd edn. Oxford University Press. 2003.
2. Trovor Palmer. Enzyme- Biochemistry, Biotechnology, Clinical chemistry. East West Press Pvt Ltd. 2004.
3. Bommanius A.S. and R. Riebel. Biocatalysis. Wiley-VCH. 2004.
4. Octave Levenspiel. Chemical Reaction Engineering. 3rd Edition. John Wiley and Sons. 1999.

GENETIC ENGINEERING TECHNIQUES
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – I

Course Code	**18BBT153**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: The course will enable the students

- To impart theoretical knowledge of the Molecular Biology and Genetic Engineering.
- To develop technical skills including the ability to design & conduct experiments
- To use appropriate analytical methods to critically review the experimental observations and results

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
DNA REPLICATION: Comparative account on initiation, elongation and termination in prokaryotes and eukaryotes DNA Repair: Mismatch correction, Mechanisms in thymine-dimer repair: Photoreactivation, Nucleotide excision repair, SOS repair DNA Recombination: Homologous and non-homologous recombination; Holliday Model; Site specific recombination: General mechanism, Examples: SSR in Bacteriabacteriophage, FLP/FRT and Cre/Lox recombination. Transcription: Prokaryotic & Eukaryotic Mechanisms; Significance of Promoters, Enhancers,Silencers, Transcription factors, Activators and repressors; Post transcriptional modifications;Transcription inhibitors	
MODULE -2	
GENETIC CODE AND ITS PROPERTIES: Wobble hypothesis. Translation: Role of Ribosomes &tRNA; Mechanism of translation: Activation of amino acids, initiation complex formation, elongation of polypeptide, termination and release of polypepetide; Posttranslational modifications; Transport of proteins and molecular chaperones. Transcriptional regulation in Prokaryotes: General mechanism of positive and negative control; Operon concept: lac, trp, and gal operons; Transcriptional control in Eukaryotes: Chromatin remodeling: Acetylation and deacetylation of histone proteins; Regulatory proteins: DNA binding transactivators, coactivators; Homeotic gene and theirrole in gene regulation	
MODULE -3	
Plasmids, Phage Vectors, Phagemids, Cosmids, YACs and BACs; Cloning & Expression vectors. Enzymes ingenetic engineering: Restriction Enzymes, DNA ligase,Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase. Methods in construction of recombinant vectors; Linkers, Adaptors, Homopolymerictailing. Techniques in Genetic Engineering; Construction of libraries; Genomic and cDNA libraries. Hybridization techniques; Northern and Southern hybridizations. Polymerase Chain Reaction: General mechanism andapplications; Variants of PCR; In vitro mutagenesis.	
MODULE -4	
Microprojectile bombardment; Agrobacterium transformation, Ti plasmid: structure and functions, Ti plasmid based vectors, mechanism of T- DNA transfer;Chloroplast transformation; Transgenic science in plantimprovement: resistance to biotic and abiotic stresses, biopharming plant s as bioreactors	

MODULE – 5

Introduction of DNA into mammalian cells; Animalvectors and Transfection techniques; Transgenic sciencefor improvement of animals and livestock, animal asbioreactors for recombinant proteins. Gene transfertechniques into microbial cells: transformation,electroporation, lipofection, calcium phosphate mediated;Genetic manipulation of microbes for the production ofinsulin, growth hormones.

Course outcomes: At the end of the course the graduates should be able to:

- Gain an in-depth knowledge in the basic principles, concepts of immunology wrt the cells, molecules and pathways involved in the induction and regulation of innate and adaptive immunity
- Recognize and distinguish the immunity exhibited by humoral and cell mediated immune responses against an antigen
- Dissect, compare and infer the diversified roles of immune system, recognize the disorders of the immune system and the requirements for developing new, safe and effective therapeutics
- Acquire proficient skills and an insight into the importance, principles, limitations of immunological, pathological testing techniques including therapies in clinical practice and communicate results of research project effectively with the scientific community

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular Biology of the Cell, 4th edition, New York: Garland Science; 2002.
2. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. Molecular Cell Biology, 4th edition, New York: W. H. Freeman; 2000.
3. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001

REFERENCE BOOKS

1. Brown TA, Genomes, 3rd edition. Garland Science 2006.
2. T. A. Brown. Gene Cloning: An Introduction, Stanley Thornes Publishers Limited, 1995.
3. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001

CHEMICAL ENGINEERING AND MOLECULAR BIOLOGY LAB
[As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I

Course Code	**18BBTL16**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions) +03HoursLaboratory**	**SEE Marks**	**60**
Total Number of Lecture Hours	**48**	**Exam Hours**	**03**

CREDITS – 02

Course objectives: To provide hands on training with procedures for real time problems in chemical engineeringand to teach molecular biology technique.

Sl.No.	Laboratory Experiments:	Revised Bloom's Taxonomy(RBT) Level
1	Calculation minimum settling velocity of cells.	**L3**
2	Calculation of fluidizing velocity of immobilized enzyme system	**L4**
3	Rate of drying.	**L3**
4	Extraction of antibiotics from different organic solvent andstudying its efficiency of extraction.	**L3**
5	Study of adsorption of proteins on matrix by differentisotherms.	**L3**
6	Study of mass transfer effect on reaction of immobilizedenzymes.	**L4**
7	Isolation of genomic DNA from Bacteria/ Plant/ Animal cells and its quantification.	**L3**
8	Study of Denaturation and Renaturation of DNA and calculation of Tm value of DNA.	**L4**
9	Isolation of total RNA from *E.coli.*	**L3**
10	Preparation of Competent *E coli* cells and Transformation.	**L3**
11	Isolation of Plasmid DNA and its purification.	**L3**
12	Restriction analysis and agarose electrophoresis of DNA	**L3**

Course outcomes: On the completion of this laboratory course, the students will be able to have hands on experience on,

- All laboratory experiments are to be includedfor practical examination.
- Strictly follow the instructions as printed on the coverpage of answerscript for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part will be madezero.

TEXT/REFERENCE BOOKS

1. Hans Peter Schmauder (Editor). Methods in Biotechnology Published by Taylor & Francis. 2004.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Keith Wilson and John Walker, Pricniples and Techniques of Biochemistry and Molecular Biology, 2000.

RESEARCH METHODOLOGY and IPR
[As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I

Course Code	**18RMI17**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**02**	**SEE Marks**	**60**
Total Number of Lecture Hours	**25 (5 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 02

Course objectives: The course will enable the students

- To give an overview of the research methodology and explain the technique of defining a researchproblem
- Toexplainthefunctionsoftheliteraturereviewinresearch.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing areview.
- Toexplainvariousresearchdesignsandtheircharacteristics.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of datacollections.
- ToexplainseveralparametrictestsofhypothesesandChi-squaretest.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and businessimpactinthechangingglobalbusinessenvironment.
- To discuss leading International Instruments concerningIntellectual Property Rights

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
RESEARCH METHODOLOGY: 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, and Problems Encountered by Researchers in India. **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.	**L1,L2**
Module -2	
REVIEWINGTHELITERATURE: Placeoftheliteraturereviewin research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literaturereviewed.	**L1,L2**
Module -3	
DESIGN OF SAMPLING: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of SamplingDesigns. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of	**L1, L2**

Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale. **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	
MODULE -4	
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi SquareTests	**L1, L2, L3, L4**
MODULE – 5	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions forWriting Research Reports. **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The DesignsAct, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000,TradeSecrets,Utility Models, IPRand Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual PropertyOrganisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents,Marks, Industrial Designs,Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection ofIntellectual PropertyunderTRIPS, Copyright and Related Rights,Trademarks, Geographical indications,IndustrialDesigns, Patents, Patentable Subject Matter,RightsConferred, Exceptions, Term ofprotection, Conditions on Patent Applicants, Process Patents, OtherUse without Authorization of theRight Holder, Layout-Designsof Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO	**L1, L2,L3, L4, L5**
Course outcomes:	

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing areview.
- Explain various research designs and theircharacteristics.
- Explain the details of sampling designs, measurement and scaling techniques and also different methods of datacollections
- ExplainseveralparametrictestsofhypothesesandChi-squaretest.
- Explaintheartofinterpretationandtheartofwritingresearchreports.
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerningIPR.

Question paper pattern:

- The question paper will have tenquestions.
- Each full question is for 16marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from eachmodule.
- Each full question with sub questions will cover the contents under a module.

TEXT BOOKS:

1. Research Methodology: Methods and Techniques by C.R.Kothari,GauravGarg, New Age International,4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2) by Ranjit Kumar, SAGEPublications Ltd, 3rd Edition, 2011
3. Study Material(For the topic Intellectual Property under module 5)- Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

REFERENCE BOOKS:

1. An introduction to Research Methodology by Garg B.L et al., RBSA Publishers, 2002
2. An Introduction to Multivariate Statistical Analysis by Anderson T.W, Wiley, 3rd Edition, 2003.
3. Research Methodology by Sinha, S.C, Dhiman,EssEssPublications, 2002.
4. Research Methods: the concise knowledge base by Trochim, Atomic Dog Publishing,2005.
5. How to Write and Publish a Scientific Paper by Day R.A, Cambridge University Press, 1992.
6. Conducting Research Literature Reviews: From the Internet to Paper by Fink A, Sage Publications, 2009.
7. Proposal Writing by Coley S.M. Scheinberg, C.A, Sage Publications, 1990
8. Intellectual Property Rights in the Global Economy by Keith Eugene Maskus, Institute for International Economics, 2000

M.Tech-BIOTECHNOLOGY Stream

M.Tech-SECONDSEMESTER SYLLABUS

INDUSTRIAL BIOTECHNOLOGY **[As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II**			
Course Code	**18BBT21**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To understand the details of microbial techniques for growth, cultivation and characterization of microorganisms with industrial importance.
- To appreciate the recent developments in the area of medical microbiology, environmental microbiology, industrial microbiology, etc.

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION: The era of the discovery of Microbes, Pasteur and fermentation, The discovery of Antibiotics, Production strains, screening techniques, Growth of Industrial Fermentations, Screening techniques, Strain Development, Preservation of Micro organisms and Preparation of Inoculum.	**L1,L2, L3**
MODULE -2	
MICROBIAL TRANSFORMATION AND PRODUCTION MEDIA: Characteristics of an IdealProduction Media, Raw materials for production,Screening for production Media, Principles ofSterilization, Sterilization equipment, Sterilization ofproduction Media, Sterilization of Air.	**L1,L2,L3**
MODULE -3	
PRINCIPAL TYPES OF FERMENTOR IN INDUSTRIES: Introduction to Fermentors, Factorsinvolved in fermentor Design, Fermentor configurations,Principal operating characteristics of fermentors,Computer control of Fermentation process, Computerapplication in fermentation technology, Justification and Planning.	**L2, L3,L4**
MODULE -4	
MICROBIOLOGICAL ASSAY: Introduction and History of Assay, Microbiological assay of: Vitamins and Amino Acids, Antibiotics, Trace elements. Advantages and Disadvantages of Microbiological Assay, Automation of Microbiological Assay	**L1,L2,L3,L4**
MODULE – 5	
INDUSTRIAL APPLICATIONS OF MICROBES: Pharmaceutical sector, Food and Enzymes Industries.Fermented foods. Sewage and Sewage disposal,Objectives of Sewage treatment, Collection of Sewage,Sewage treatment Methods	**L2, L3, L4**

Course outcomes: At the end of the course the graduates should be able to:

- Understand the techniques used for the isolation, growth, identification, disinfection and sterilization of microorganisms used in the Industries.
- Define the role of microorganisms towards environmental protection, industrial applications.

- Out-line industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes, vitamins and therapeutic products.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Microbiology by Michael J PelczarJr Chan ECS, Noel R Krieg, Tata McGraw HillPublishing co ltd.
2. Microbiology by Prescott, Harley, Klein, McGraw Hill.
3. Industrial Microbiology by Samuel C Prescott, Cecil G Dunn, Agro bios (India)
4. Palynology and its applications By ShripadN.Agashe, Oxfor and IBH publishing Pvt.Ltd.
5. Biotechnological Applications of Microbes by Edite-AjitVerma, IK Intl. Pub House.
6. Alcamos Fundamentals of Microbiology by Jeffery C Pommerville, Jones and Bartlett Publishers.
7. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 2012. Pearson
8. Principles of Microbiology: Ronald M Atlas, 1995.McGraw-Hill Inc., US (addition)
9. Microbiology: Principles and Explorations, Jacquelyn G. Black, 8thEdition, John Wiley & Sons,2012.

REFERENCE BOOKS

1. The Air Spora: A manual for catching and identifying airborne biological particles. Maureen E. Lacey and Jonathan S. West. Springer.
2. Soil Microbiology by NS SubbaRao, Oxford and IBH.
3. Palynology and its applications By ShripadN.Agashe, Oxfor and IBH publishing Pvt. Ltd.
4. Text Book of Microbiology by Anantahnarayan and JayaramPanicker, Universities Press.

ADVANCED BIOINFORMATICS [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT22**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To have knowledge of molecular and genetic engineering principle to design and predict the structure of novel compounds.
- To know the principle of drug design and its applications in proteomics and genomics.
- Explore logical and critical thinking ability to solve biological problems with the help of BioPerl and other bioinformatic techniques

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
BASIC CONCEPTS OF MOLECULAR BIOLOGY: Proteins, Nucleic Acids: DNA, RNA. Molecular Genetics: Genes and Genetic code, Transcription, Translation and Protein synthesis, Chromosomes Genome: Maps and Sequences, Sequencing Techniques, Human Genome project, Sequence Databases.	**L1,L2, L3**
MODULE -2	
BIOLOGICAL DATABASES: Types of databases – Primary and Secondary biological databases. Primary databases, secondary databases, genotype databases, molecular structure databases and genome databases. Hidden Markov Models: Forward and Backward algorithm, Viterbi algorithm, Applications: Modeling Protein sequence families, multiple alignments.	**L2, L3,L4**
MODULE -3	
PROTEIN MODELING AND INSILICO DRUG DESIGN: Protein structure, signal peptides, transmembrane proteins, analysis of protein structures. Protein modeling, modeling protein structures using High Throughput methods. Insilico drug design, Virtual Library design, vHTS and Scaffold Hopping, Predictive Science (Biological Activity, ADMET). Structure based Drug Design (SBDD), Lead Optimization, Structural Mining: Protein Ligand work analysis. Study of drug-interactions, Docking.	**L1,L2,L3**
MODULE -4	
PERL AND BIOINFORMATICS: Basics of PERL, Sequence analysis and alignment, Evolutionary analysis. Metabolomics. Working with Discovery Studio (Molecular Modeling): 2D and 3D visualization, 2D and 3D moleculardescriptors, Quantum mechanics / molecular, mechanics. SAR analysis, 2D and 3D QSAR. Bayesian statistics, neural networks, recursive partitioning, GFA, etc. Library analysis and Library design. Predictive ADME and toxicology (TOPKAT®), Conformation generation and Analysis. Structure-based and structure-guided design, docking, scoring. Virtual screening and compound ranking/scoring	**L2,L3,L4, L5**
MODULE – 5	

RECEPTOR-LIGAND INTERACTIONS ANALYSIS: Fragment-based design, de novo design (LUDI), Pharmacophore generation (Catalyst), Scaffold hopping, 3D database screening, Simulations, molecular mechanics/dynamics (CHARMm). Explicit/implicit solvation models, Transmembrane protein modeling, Homology modeling, Antibody modeling, Electrostatics calculations, protein ionization and prediction, Protein modeling (MODELER®) and analysis, protein engineering. Protein-protein docking and refinement, Sequence analysis, sequence alignment, phylogenetic analysis, XRay (CNX), structure refinement and analysis	**L1, L2, L3, L4,**

Course outcomes: At the end of the course the graduates should be able to explain the overview of bioinformatics and biological databases, use the knowledge of docking to know the 3D structure of receptor; its scope and limitation.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. David W. Mount. “Sequence and Genome Analysis”, Bioinformatics CSHL Press, 2nd Ed., 2004.
2. Baxevanis and F. B. F. Ouellette. “Bioinformatics: a practical, guide to the analysis of genes and proteins”, JohnWiley, 2nd Ed., 2001.
3. Jonathan Pevsner. “Bioinformatics and Functional Genomics”, Wiley-Liss, 1st Ed., 2003.

REFERENCE BOOKS

1. Setubal Joao and meidanis Joao, Introduction to Computational Molecular Biology,Publisher: PWS Publishing; 1st edition, 1997.
2. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, Biological Sequence Analysis,Cambridge. Cambridge University Press, 1998.
3. Paul M. Selzer, Richard J. Marhöfer, Andreas Rohwer, Applied bioinformatics: anintroduction, Berlin Springer 2008.

AGRICULTURAL BIOTECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT23**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To understand the significance of sustainable development Agricultural biotechnology.
- To comprehend the importance of various technologies to protect economical crops.
- To appreciate the importance of Genetically modified plants and their management

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION TO AGRICULTURAL BIOTECHNOLOGY: Introduction, history and scope ofagriculture in India. Staple food, fiber, fuel and fruitcrops of India and abroad, Agro-climatic zones andcropping pattern of India. Conventional cropimprovement programs- Introduction, Selection andHybridization, Mutation, Haploidy and PolyploidyBreeding. Modern agriculture biotechnology for foodsecurity and national economy. Green-revolution.	**L1,L2, L3**
MODULE -2	
APPLICATIONS OF PLANT TRANSFORMATION TECHNOLOGY: Productivity and performance disease resistance, genes and gene constructs used for viralresistance by coat protein mediated production, bacterialresistance by lysozyme gene and fungal resistance bychitinase and beta glucanase genes. Agrobacteriummediated tranformation. Crop improvement to resistadverse soil conditions. Salinity tolerance, droughtresistance. Herbicide resistance in commerciallyimportant plants. Insecticide resistance through BT-gene.Integrated pest management. current status of BT crops inthe world. Effect of transgenic crops on environment	**L2, L3,L4**
MODULE -3	
INTRODUCTION TO PLANT CELL CULTURE: Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plant regeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds"; haploid production: advantages and methods. Protoplast technology	**L2, L3, L4**
MODULE -4	
ANTISENSE RNA TECHNOLOGY(ACC synthase gene and polygalacturonase): Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato, banana. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses following harvest using biotechnology. Biotechnology for fortification of agricultural products-	**L2,L3,L4, L5**

Golden rice, transgenic sweet potatoes. Importance of biofertlilizers in agriculture. (Rhizobium azatobacter, Mycorrhiza, Frankia and Blue green algae) current practices and production of biofertilizers	
MODULE – 5	
AN OVERVIEW OF LEGAL AND SOCIOECONOMIC IMPACT OF BIOTECHNOLOGY: Biotechnology & hunger. Ethical issues associated with labeling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals, guidelines for research, environmental aspects of BT applications	**L1, L2, L3, L4,**
Course outcomes: At the end of the course the graduates should be able to • Demonstrate strong basics in principles of Agricultural Biotechnology • Appreciate the ability to use biotechnology for sustainable development.	
Question paper pattern: • Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks. • Eachfullquestioncanhaveamaximumof4subquestions. • There will be 2 full questions from each module covering all the topics of the module. • Students will have to answer 5 full questions, selecting one full question from eachmodule. • The total marks will be proportionally reduced to 60 marks as SEE marks is 60.	
TEXT BOOKS 1. Singh BD (2003) Biotechnology- Expanding Horizons. Kalyani Publishers, Rajindernagar, Ludhiana. 2. Bhojwani SS and Razdan MK (1996) Plant Tissue Culture: Theory and Practice, a revised edition. Panima Publishing Corporation, New Delhi.	
REFERENCE BOOKS 1. Lindsey, K and Jones. (1990) Plant biotechnology in Agriculture. Prentice Hall, USA. 2. Rajashekaran K, Jacks TJ and Finley JW (2002) Crop Biotechnology. American Chemical Society, Washington, DC	

Professional Elective -2

SYSTEMS BIOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To appreciate the concepts underlying in various tools in systems biology.
- To comprehend the essentials of design of systems biology
- Prepare them to leverage their knowledge connectivity in biological sciences

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION TO SYSTEMS BIOLOGY: Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Mass Spectrometry and systems Biology. Bioinformatics databases supporting systems biology approaches	**L1,L2, L3**
MODULE -2	
NETWORK MODELS AND APPLICATIONS: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Integrated Imaging Informatics- ntegrin, centroid, cell culture. Standard platforms and applications - metabolic control analysis, glycolysis, metabolic network, Michaelis-Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase. Biological Processes - mitochondria, cyclin, Cdc2. Modeling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data - support vector machines, cDNA microarray. Evolution and Self organization - hypercycle, quasispecies model, self-replication. Reconstruction of metabolic network from Geme Information	**L1,L2, L3**
MODULE -3	
INTEGRATED REGULATORY AND METABOLICMODELS: Phosphorylation, Gene expression, andMetabolites. Estimation Modeling and Simulation -Circadian rhythms, Petri net, mRNA. Deterministic -Circadian rhythms, mRNA, Circadian oscillations. Multiscale representations of Cells and Emerging Phenotypes -Gene Regulatory Networks, attractor, and Booleanfunctions. Mathematical models and Optimizationmethods for De Novo Protein design. Global Geneexpression assays. Mapping Genotype - Phenotype relationship in cellular networks	**L2, L3, L4**
MODULE -4	
MULTISCALE REPRESENTATIONS OF CELLS AND EMERGING PHENOTYPES:Multistability andMulticellurarity,	**L1,L2,L3,L4**

Spatio-Temporal systems biology,Interactomics, Cytomics – from cell state to predictivemedicine.	
MODULE – 5	
MODELING TOOLS: SBML, MathMLCellML, Petri Nets and Boinformatics tools with case studies and discussions.	**L1, L2, L3, L4,**

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles of systems biology.
- Tackle live problems in various spheres of biological sciences.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Computational Systems Biology by Andres Kriete, Roland Eils. Academic Press, 2006.
2. Systems Biology by Andrzej K. Konopka, CRC, 2006.
3. Systems biology in practice: concepts, implementation and application by EddaKlipp,
4. WileyVCH, 2005.
5. Systems Biology by IsidoreRigoutsos, G. Stephanopoulos, Published by Oxford University Press US, 2006.
6. Theoretical Models in Biology by Glenn Rowe, Oxford University Press – Publisher, 2004.

REFERENCE BOOKS

1. Transactions on Computational Systems Biology I by CorradoPriami, Springer – Publisher, 2009.
2. Systems Biology by Fred C. Boogerd, H.V. Westerhoff, Elsevier – Publisher, 2007.
3. Sangdun Choi. Introduction to Systems Biology, Humana Press.2007.
4. Michael G. Katze.Systems Biology. Springer, 2013.
5. Konopka A.K. Systems Biology: Principles, Methods, and Concepts. CRC Press, Tailor & Francis.2007.
6. Robert A. Meyers. Systems Biology, Wiley Blackwell. 2012.

IMMUNOTECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT242**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To describe the basic principles, concepts of Immunology and understand the organs,cells, molecules as well as pathways involved in the induction and regulation of innate& adaptive immunity
- To gain an understanding on the characteristics of antigens, antibodies, humoral, cell mediated immune responses and their regulatory responses
- Integrate information on the role of the immune system in complement system, hypersensitivity, transplantation, immuno-disorders, Tumors and the requirements for developing new safe and effective therapeutics
- Demonstrate a comprehensive understanding of the theory behind the immunotechniques used in the research project, diagnosis and show a critical awareness of how these techniques can be applied to biological problems

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
THE IMMUNE SYSTEM: Introduction: Phylogeny of Immune system, Immunity, Clonal nature of immune response. Organisation and structure of lymphoid organs and cells. Nature and Biology of antigens and antibodies classes, subclasses and determinants.	**L1,L2, L3**
MODULE -2	
LYMPHOCYTE MEDIATED IMMUNITY:B-lymphocytes and their activation; Genetic control ofantibody production, production of monoclonal andpolyclonal antibodies. MHC Complex, antigen presenting cells (APC), mechanisms of T cell activation, Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity Antigen processing and presentation	**L1,L2,L3,L4**
MODULE -3	
IMMUNE REGULATION AND THERAPY: Complement activation**,** cytokines, Hypersensitivity,Autoimmunity, Immuno-deficiency, production ofrecombinant-DNA vaccines. Catalytic antibodies,application of PCR technology to produce humanized antibodies, immunotherapy with genetically engineered antibodies.	**L2, L3,L4**
MODULE -4	
TRANSPLANTATION IMMUNOLOGY: Immunological basis of graft, types of transplantation,mechanism of graft rejection, role of HLA in graftrejection, tissue typing, immuno-suppression andimmunosuppressive drugs, immuno-tolerance, tumor specific antigens, mechanism of AIDS.	**L3, L4, L5**
MODULE – 5	
IMMUNODIAGNOSIS: Antigen antibody interaction – Precipitation reactions,Agglutination reactions, Blood typing, A, B, ABO &Rh, principles and applications of ELISA, RadioImmuno Assay (RIA),	**L3, L4, L5**

western blot analysis, immunoelectrophoresis,surface Plasmon resonance(SPR)based immunoassay, immuno-fluorescence,chemiluminescence assay, FACS	

Course outcomes: At the end of the course the graduates should be able to:

- Gain an in-depth knowledge in the basic principles, concepts of immunology wrt the cells, molecules and pathways involved in the induction and regulation of innate and adaptive immunity
- Recognize and distinguish the immunity exhibited by humoral and cell mediated immune responses against an antigen
- Dissect, compare and infer the diversified roles of immune system, recognize the disorders of the immune system and the requirements for developing new, safe and effective therapeutics
- Acquire proficient skills and an insight into the importance, principles, limitations of immunological, pathological testing techniques including therapies in clinical practice and communicate results of research project effectively with the scientific community

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Sharon J.,"Basic Immunology" Williams and Wilkins. (1998).
2. Roitt I., Brostoff, J and Male, D., "Immunology", Mosby Publ. (2002).
3. Kuby J., "Immunology", W.H. Freeman & Co. (2006).

REFERENCE BOOKS

1. Janeway C. and Travers P., "Immunobiology", Garland Publ. (2001).
2. Abbas A., Litchman A. H., and Pober J., "Cellular and Molecular Immunology" W B Saunders& Co.(2000)

INDUSTRIAL ECONOMICS [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To appreciate the Basic concepts of industrial economics
- To understand and apply the different strategies

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
CONCEPT AND ORGANIZATION OF A FIRM: Ownership, control and objectives of the firm; Growth of the firm – Size and growth of a firm, growth and profitability, constraints on growth; Recent trends in Indian industrial growth; Progress and Problems of some major industries in India-Special emphasis on Biotech industries	**L1,L2, L3**
MODULE -2	
REGIONAL INDUSTRIAL GROWTH AND PRODUCTIVITY: Regional industrial growth in India; Industrial economic concentration and remedial measures; Development of Cottage and small scale industries concept and measurement; Indian situation. Theories of industrial locations – Weber and Sargent theories, Factors affecting location	**L2, L3,L4**
MODULE -3	
INDUSTRIAL FINANCE : Sources of short term and long term finance; Industrial Financial Institutions: Role and functioning in India; Corporate securities; Ownership and creditor-ship securities concentration; Economies of Scale; Market structure and profitability; Market structure and innovation; Product pricing – theories and evidence	**L2, L3, L4**
MODULE -4	
METHODS OF PROJECT EVALUATION: Ranking of Projects – NPV and IRR; Social cost-benefit Analysis; Theories and empirical evidence on Mergers and Acquisitions (M & A's) and diversification. Structure of Industrial labor; Employment dimensions of Indian Industry, Industrial legislation	**L2,L3,L4**
MODULE – 5	
INDUSTRIAL RELATIONS AND POLICY IN INDIA: Worker's participation in management and Collective Bargaining; Exit policy and social security; Second National Commission on labor. Classification of industries and role of public and private sectors. Competition Act, 2002, MNCs and transfer of technology. Industrial legislation – Industrial Disputes Act and Factories Act	**L1, L2, L3**

- **Course outcomes:** At the end of the course the graduates should be able to
- Demonstrate strong basics in principles of industrial economics □

- Demonstrate the ability to manage industrial projects

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Ahluwalia, I.J. (1985), Industrial Growth in India, Oxford University Press, New Delhi.
2. Barthwal, R.R. (1985), Industrial Economics, Wiley Eastern Ltd. New Delhi.
3. Cherunilam, F. (1994), Industrial Economics: Indian Perspective (3rd Edition), Himalaya Publishing House, Mumbai.
4. Desai, B. (1999), Industrial Economy in India (3rd Edition), Himalaya Publishing House, Mumbai
5. Divine, P.J. and R.M. Jones et. al. (1976), An Introduction to Industrial Economics, George Allen and Unwin Ltd., London.
6. Government of India, Economic Survey (Annual).
7. Hay, D. and D.J. Moris (1979), Industrial Economics: Theory and Evidence, Oxford University Press, New Delhi.
8. Kuchhal, S.C. (1980), Industrial Economy of India (5th Edition), Chaitanya Publishing House, Allahbad.

REFERENCE BOOKS

1. Harndeen, J.B. (1975), The Economics of Corporate Economy, Dunellen Publishers, New York.
2. Kemien, M.T. and N.L. Schwartz (1982), Market Structure and Innovation, Cambridge University Press, Cambridge.
3. *BOARD OF STUDIES IN BIOTECHNOLOGY. VTU, BELGAUM, KARNATAKA.*
4. Bagchi, A. and M. Banerjee (Eds.) (1979), Change and Choice in Indian Industry, Bagchi Publications, Calcutta.
5. Kelkar, V.L. and V.V. BhnojiRao (Eds.) (1996), India Development Policy Imperatives, Tata McGraw Hill, New Delhi.
6. Brahmananda, P.R. and V.R. Panchmukhi (Eds.) (1987), The Development Process of the Indian Economy, Himalaya Publishing, Bombay.
7. Chakravarty, S. (1987), Development Planning: The Indian Experience, Oxford University Press, New Delhi.

Professional Elective-3

FOOD BIOTECHNOLOGY
[As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II

Course Code	**18BBT251**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: The course will enable the students

- Understand the components of food and principles of food spoilage and techniques for food preservation.
- Know the application of biotechnology for food preservation and food production with improved nutritional benefits

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
BASIC CONSTITUTES OF FOOD: Basic constituents of food, colloidal systems in food, molecular stability of colloidal systems, types of food starches, soluble fibers: pectin's, mucilage & gums, protein rich foods, oils in foods. Food Microbiology: Microbial growth pattern, types of microorganisms associated with food: mold, yeast and bacteria. Contaminants of food stuff, milk and meat during handling and processing. Mechanism of food spoilage. Biochemical changes caused by microorganism. Determination of various types of food products. Food borne intoxicants and mycotoxins.	**L1,L2, L3**
MODULE -2	
FOOD PRESERVATION TECHNOLOGY: Food preservation by high and ultra high temperatures- canning, drying. Food dehydration: Equipments for food dehydration: fixed tray dehydration, cabinet drying, tunnel drying. Freeze dehydration, controlled atmosphere, storage, Food preservation by irradiation treatment. Preservation by freezing and refrigeration. Frozen foods. Thermal properties of frozen foods. Food freezing equipments: Air blast freezers, plate freezers and immersion freezers. Preservation by Chemicals and Bacteriocins.	**L2, L3,L4**
MODULE -3	
INTRODUCTION TO PLANT CELL CULTURE: Explant selection, sterilization and inoculation; Various media. Food Production Technology: Importance of food industry, specific objectives of food processing, impact of foodprocessing on food constituents. Production of single cell protein, Tailoring of milk proteins and milk fats, Production of fermented food products: yoghurt, probiotic cheese. Nutritional value, labeling of constituents: Soya foods, organic foods, dietary foods, nutritional food supplements, Use of plant cell culture for the production of food additives (Vanillin, Capsaicin),microbial transformations, regulatory and social aspects of BT. Food packaging, edible films, Marketing of food and promotional strategies.	**L2, L3, L4**

MODULE -4	
BIOTECHNOLOGY FOR IMPROVED PROCESSING: Role of biotechnology in food industry, maintenance of nutritional quality, Enzymes in bakery and cereal products, utilization of hydrolases and lipases enzymes. Applications of immobilized enzymes in food industry, enzymes for enhanced flavor and aroma compounds, enzymes in fat and oil industries. Genetically modified plants for high nutritional food.	**L1,L2,L3,L4**
MODULE – 5	
FOOD QUALITY ASSURANCE AND CONTROL: Importance and functions of quality assurance and control. Methods of quality, concept of rheology, assessment of food materials- fruits, vegetables, cereals, dairy products, meat and processed food products. Microbiological safety of food products, chemical safety of food products, contaminants by heavy metal, fungal toxins and pesticide residue. Food regulations, grades and standards, USFDA/ ISO 9000 Series. Food adulterations and safety, sensors and instrumental analysis in quality control food laws and standards.	**L1, L2, L3, L4,**

Course outcomes: At the end of the course the graduates should be able to

- Enlighten with comprehensive knowledge of biotechnological applications to food industry.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. James M, Jay. Food Biotechnology CBS Publishers , 2nd edition, 2005.
2. Kalidasshetty Food Biotechnology, CRC Press. 1st ed. 2005
3. T.Britze, R.K Robinson., Advanced Dairy Science and Technology. Wiley- Blackwell publisher. 1st edition. 2008

REFERENCE BOOKS

1. H. Elmer, L James, Marath and Steele. Applied dairy microbiology, CRC press, 2nd edition, 2005.
2. R. Paul Singh., "Introduction to Food Engineering", Academic Press, 3rd Ed., 2004.
3. P. Fellows, "Food Processing Technology: Principles and practice". WoodheadPublishing Ltd., Cambridge, 2nd Ed., 2005.

CLINICAL BIOTECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT252**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To understand and emphasis on the various domain of clinical trials and drugMetabolism
- To evaluate the intensity and integrity of various diseases and implications of variousgoverning agencies

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
Introduction: Introduction to Clinical study and design of clinical studies. Epidemiological research and treatment studies: Double-blind andSingle-blind Randomized controlled trial, Non-blind trial, Nonrandomized trialquasi- experiment. Observational studies: Cohort study- Prospective cohort and Retrospective cohort.Time series study, Case-control study andNested case-control study. Community survey and Ecological study. Seasonal studies: Conduction of studies in seasonal indications such as Allergies and Influenza.	**L1,L2, L3**
MODULE -2	
STATISTICAL ANALYSIS AND INTERPRETATION: Background and purpose, trial design consideration, Parallel group design, cross over design, factorial design. Introduction to Statistical Application Software (SAS), procedures and clinical data management.	**L2, L3,L4**
MODULE -3	
DRUG DESIGN AND SYNTHESIS: Synthesis of compounds in accordance with the molecular structure and biological activity concept: Analgesics, neuromuscular blocking agents, anti-fertility drugs and bactericidal & bacteriostatic agents (sulphonamides, mercury compounds and antiseptics). Study of Therapeutic Proteins and Related Case Studies.Blood and Blood products: Clotting factors, anticoagulants, Thrombolytic Agents, Tissue plasminogen activator and streptokinase. Safety guidelines in Blood Transfusion. Therapeutic Proteins: Antibodies, Enzymes, Hormones, Growth factors (Erythropoietin), Vaccines (HIV and Cancer), Interferon and Interleukins.	**L2, L3, L4**
MODULE -4	
CANCER BIOLOGY AND THERAPY: Introduction to cancer biology and modes of treatment: radiotherapy, chemotherapy,	**L1,L2,L3,L4**

surgery, Biological therapy, immunotherapy and gene therapy. Clinical Toxicology: Basic concept in toxicology. Types and mechanism of toxin action- Epoxidation& drug toxicity, N-oxidation & drug toxicity and sulphurxenobiotics. Hepatotoxicity and Nephrotoxicity. Biotransformation of toxins, inactivation and removal from the body.	
MODULE – 5	
CLINICAL RESEARCH GOVERNANCE AND ETHICS: Overview on regulatory affairs for pharmaceuticals, neutraceuticals and medical devices. Good Clinical Practices (GCP) And International quality standard and related guidelines (ICH-E6). Risk assessment and trial monitoring. Legal and ethical issues on biotechnology, medical research and related clinical practice.	**L1, L2, L3, L4,**

Course outcomes: At the end of the course the graduates should be able to

- differentiate between drug toxicity and drug concentration along with the mechanismof various interactions of health sectors.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Designing clinical research by Stephen B. Hulley, 3rd Edition, 2007
2. Principles and practice of clinical research by John I. Gallin, Frederick P. Ognibene, 2nd Edition, 2006.
3. Conducting GCP- Compliant Clinical Research: A Practical Guide by Wendy Bohaychuk, Graham, Ball University Edition John Wiley & Sons Ltd, New York,2009.

REFERENCE BOOKS

1. Pharmaceutical Perspectives of Cancer Therapeutics by Ram I. Mahato, Yi Lu University Edition, Springer Dordrecht Heidelberg London, 2001.
2. Design and analysis of clinical trials: concepts and methodologies by Shein-Chung Chow, Jen-pei Liu, 2nd Edition, John Wiley & Sons Ltd, New York, 2004
3. New drug development: design, methodology, and analysis by J. Rick Turner University Edition John Wiley & Sons Ltd, New York. 2004

PHARMACEUTICAL BIOTECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Course Code	**18BBT253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To understand the significance of Pharmaceutical biotechnology towards sustainable development
- To comprehend the importance of various technologies and practices in pharmaceutical industries

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION: Introduction to pharmaceutical biotechnology, pharmacokinetic concepts, current research trends, new advances and approved biologicals for pharmaceutical use and manufacturing principles. Quality assurance and control; Concept of GMP, GLP.	**L1,L2, L3**
MODULE -2	
THERAPEUTICS BASED ON BIOTECHNOLOGY: Hematopoietic growth factor and coagulation factors,interferons and cytokines; Preparation andstandardization of hormones-thyroid, insulin and growthhormones; Enzymes-Enzymatic therapy and monographs; antibiotics and their derivatives-penicillin, streptomycin, tetracycline, cephalosporins, macrolides, peptide antibiotics (any two); vaccines BCG, DPT, Poliomyelitis, Typhus, toxoids-diptheria and tetanus; antitoxinsdiptheria and gas-gangrene(any two); others-whole human blood, dried human plasma, gamma globulins, clinical dextran and absorbable haemostats, uses, and storage.	**L2, L3,L4**
MODULE -3	
BIOTRANSFORMATION: Introduction, methods used in biotransformation, steroid transformation, contraceptives, L- Dopa, chemical reactions and mechanisms (hydroxylation, aromatization, synthetic routes, epoxidation and others), production and application of monoclonal antibodies.	**L2, L3, L4**
MODULE -4	
NUTRACEUTICALS: Antioxidants, flavanoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, deficiency diseases, nutritional status evaluation. Drug delivery systems: Introduction to drug delivery systems and methods, overview of barriers, calculation of drug metabolism and, pharmacodynamics.	**L1,L2,L3,L4**
MODULE – 5	
RECOMBINANT PROTEINS AND PROTEOMICS	**L1, L2, L3, L4,**

IN DRUG DEVELOPMENT: Role of proteomics in drug development
Application of recombinant proteins in pharmaceutical industry, health care and future prospects.

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles of Pharmaceutical Biotechnology
- Appreciate the ability to use biotechnology for sustainable development.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Walsh G (2003). Biopharmaceuticals: Biochemistry and Biotechnology, Second Edition. John Wiley & Sons Ltd.
2. Pharmaceutical Biotechnology:Fundamentals and Applications, Editors: Crommelin, Daan J. A., Sindelar, Robert D., Meibohm, Bernd (Eds.) 2013
3. Modern Biopharmaceuticals: Recent Success Stories by JorgKnablein 2013, Wiley-Blackwell
4. Modern Biopharmaceuticals: Design, Development and Optimization, 4 Volumes Set 2005 by Jorg Knablein2013, Wiley-Blackwell
5. Pharmaceutical biotechnology by Ashutoskar
6. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Second Edition 2012 by Oliver Kayser, HeribertWarzechawiely publishing house

REFERENCE BOOKS

1. Manfred E. Wolff Burger's Medicinal Chemistry and Drug Discovery (5th edition) Wiley & Sons, Inc. 2000.
2. Binghewang, Terunasiahaan, Richard soltero Drug delivery: principles and applications John wiley& sons, 2005
3. Michael D. Coleman Human Drug Metabolism: An Introduction John Wiley & Sons, 2005
4. Ala F. Nassar, Paul F. Hollenberg, and JoAnn Scatina Drug metabolism handbook concepts and applications John wiley& sons 2009.

INDUSTRIAL BIOTECHNOLOGY LAB
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – II

Course Code	**18BBTL26**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions) +03HoursLaboratory**	**SEE Marks**	**60**
Total Number of Lecture Hours	**48**	**Exam Hours**	**03**

CREDITS – 02

Course objectives: To understand the details of microbial techniques for growth, cultivation andcharacterization of microorganisms with industrial importance..

Sl.No.	Laboratory Experiments:	Revised Bloom's Taxonomy(RBT) Level
1	Media preparation, Preparation of plates and tubes	L1, L2,L3, L4,L5
2	Pure culture techniques (Streak, pour and spread - plates)	L1, L2,L3, L4,L5
3	Growth curve studies.	L1, L2,L3, L4,L5
4	Antibiotic sensitivity tests.	L1, L2,L3, L4,L5
5	Characterization of bacteria by Biochemical Tests: IMViC, Starch hydrolysis, carbohydrate fermentation, Catalase, Urease, hydrogensulphide, Nitrate reduction.	L1, L2,L3, L4,L5
6	Media optimization by PlackettBurman Design, Response Surface Methodology	L1, L2,L3, L4,L5
7	Tray Drier	L1, L2,L3, L4,L5
8	Salting in and Salting out.	L1, L2,L3, L4,L5
9	Batch operation and optimization of a bioreactor	L1, L2,L3, L4,L5
10	Fed batch operation of a bioreactor.	L1, L2,L3, L4,L5
11	Product recovery by filteration.	L1, L2,L3, L4,L5
12	Product purification by chromatography	L1, L2,L3, L4,L5

Course outcomes: On the completion of this laboratory course, the students will be able to have hands on experience on,

- Prepare the media and use for the cultivation of the microorganisms.
- Perform laboratory experiments for the isolation, identification and characterization of microorganisms.
- Carry-out experiments for the enumeration, staining and control

Conduct of Practical Examination:

- All laboratory experiments are to be includedfor practical examination.
- Strictly follow the instructions as printed on the coverpage of answerscript for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part will be madezero.

TEXT/REFERENCE BOOKS

1. Lab Math by Dany Spencer Adams, IK Intl. Pub house.
2. Lab Ref by JaineRoskams& Linda Rodgers IK Intl.Pub house.
3. Case-Microbiology: An Introduction by Gerard J. Tortora, Berdell R. Funke, Christine L. 11thEdition- Pearson publications.
4. Laboratory Manual Of Microbiology And Biotechnology by Aneja K.R. Medtec,
5. 2014

TECHNICAL SEMINAR [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Sub. Code :	18BBT27	CIE Marks :	100
CREDITS – 02			

M.Tech-BIOTECHNOLGY Stream
M.Tech-THIRDSEMESTERSYLLABUS

BIOSAFETY AND BIOETHICS [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – III			
Course Code	**18BBT31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To understand and apply different methodologies of scientific research.
- To appreciate the Basic concepts of regulations in the biotech sector
- To apply the principles of biosafety guidelines in biotech practices

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
BIOTECHNOLOGY AND SOCIETY: Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.	**L1,L2, L3**
MODULE -2	
LEGAL ISSUES & BIOETHICS: The legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues	**L2, L3,L4**

MODULE -3	
BIOSAFETY CONCEPTS: Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.	**L2, L3, L4**
MODULE -4	
REGULATIONS: Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.	**L2,L3,L4**
MODULE – 5	
OTHER SECTORS: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.	**L1, L2, L3, L4,**

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles of biosafety issues and good laboratory practices

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Biotechnology and Safety Assessment by Thomas, J.A., Fuch, R.L, Academic Press.
2. Biological safety Principles and practices) by Fleming, D.A., Hunt, D.L, ASM Press.
3. Biotechnology - A comprehensive treatise. Legal economic and ethical dimensions VCH.
4. Bioethics by Ben Mepham, Oxford University Press.
5. Bioethics & Biosafety by R Rallapalli&Geetha Bali, APH Publication

REFERENCE BOOKS

1. BIOETHICS & BIOSAFTEY by SATEESH MK, IK Publishers

2. Biotechnologies and development by Sassaon A, UNESCO Publications.
3. Biotechnologies in developing countries by Sasson A, UNESCO Publishers.
4. Intellectual Property Rights on Biotechnology by Singh K. BCIL, New Delhi.
5. WTO and International Trade by M B Rao. Vikas Publishing House Pvt. Ltd.
6. IPR in Agricultural Biotechnology by Erbisch F H and Maredia K M. Orient Longman Ltd.
7. Cartagena Protocol on Biosafety.
8. Biological Warfare in the 21st century by M.R. Dano, Brassies London.
9. Safety Considerations for Biotechnology, Paris, OECD.
10. Biosafety Management by P.L. Traynor, Virginia polytechnic Institute Publication

ENVIRONMENTAL BIOTECHNOLOGY [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – III			
Course Code	**18BBT32**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: The course will enable the students

- To understand the significance of sustainable development and protection of ecosystem
- To comprehend the importance of various treatment technologies to clean up the environment

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
INTRODUCTION TO ENVIRONMENT: Concerns pertaining to Ecological damage, Environmental Pollution Types - Water, Soil, Air, Noise and Thermal pollutions, their sources and ecological effects of pollutants on living and non-living systems.. Acid rain: sources and solutions. Significance of GHGs and carbon footprint; Biodegradation, of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution. Microbial desulfurization of coal. Environmental implications of Acid mine drainage and its remediation; Role of Biotechnology in providing solutions to environmental problems	**L1,L2, L3**
MODULE -2	
BOD, COD and TOC : Estimation and correlation; Definition of Waste; Physical, Chemical and Biological characteristics of Industrial waste. Nitrification and Denitrification and their kinetics; Wastewater treatment systems. Waste Management in different industries (food processing, leather tanning, pharmaceutical, textile) Solid waste management: landfills, composting, earthworm treatment, recycling and processing of organic residues, Sources and dispersion of atmospheric pollutants and dispersion models. Control methods for air pollutants, noxious pollutants and odor control; Design of air pollution control equipments; Photochemical reactions.	**L2, L3,L4**
MODULE -3	
WASTE TREATMENT METHODS: Types (Suspended and Attached growth processes), Aerobic and Anaerobic treatment of wastes; Other biological treatment process, Anaerobic digestion – Stoichiometry & Kinetic relationships, design consideration, Process modeling and control, Biological nutrient removal, Biological treatments with Case studies; Bioremediation types and biorestoration of contaminated lands. Handling of hazardous wastes from bioprocess industries and related case studies	**L2, L3, L4**
MODULE -4	
ENVIRONMENTAL SENSING TECHNIQUES: Characterization	**L2,L3,L4**

of water contaminants and their measurement Spectroscopic techniques, AAS, NAA, GCMS, HPLC, Electro analytical techniques, Environmental sensing techniques. Discussions with Case studies	
MODULE – 5	
ENVIRONMENTAL POLICIES AND REGULATIONS: Waste minimization and its plan; Conservation of water and energy, Fugitive loss, Programs of municipal pollution control, Risk evaluation and decision analysis. Sustainable development, Environmental Management Systems, ISO and ISO 14000 series: Introduction, Areas covered in the series of standards, Necessity of ISO certification, Environmental Auditing; Other tools for environmental management, Environmental Impact assessment(EIA) and its future and scope. Objectives, Elements of EIA, Baseline studies Methodologies of EIA , Types of impacts, Prediction of impacts and its methodology, Uncertainties in EIA, Status of EIAs in India. EIA at various industries	**L1, L2, L3**

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles of environmental biotechnology for sustainable development and protection of our ecosystem□
- Apply the foundation principles and technologies to tackle live problems in various spheres of environmental sciences

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Pradipta Kumar Mohapatra, Textbook of Environmental Biotechnology, I K International, 2007
2. Buckingham and Evans, Hazardous Waste Management, LaGrega, 2nd Edition, McGraw Hill International Edition, 2001.
3. Noel De Nevers Air Pollution Control Engineering, 2nd Edition, McGraw Hill International Edition, Tata McGraw Hill, 2003

REFERENCE BOOKS

1. Bailey &Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill International Edition, 1986
2. Standard Methods for the Examination of Water and Waste Water, 22nd Edition , American Public Health Association, American Water Works Association & Water Environment Federation, 2012.
3. Environmental Management, N K Uberoi, 2nd Edition, Excel Books publication, 2007
4. Environmental Impact Assessment, Canter, 2nd Edition, McGraw Hill International Edition,1996

Professional Elective 4

PROJECT MANAGEMENT **[As per Choice Based Credit System (CBCS) Scheme]** **SEMESTER – III**			
Course Code	**18BBT331**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- To Appreciate the Basic concepts of □□Project management□
- To understand and apply the different principles of project management methodologies. □
- To learn the translation of Proof-of-concepts to product realization, and product life cycles, marketing, IPs, regulatory affairs etc

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
PROJECT PLANNING: Scope – problem statement – project goals – objectives – success criteria –assumptions – risks – obstacles – approval process – projects and strategic planning. Project implementation – project resource requirements – types of resources – men –materials finance. Case studies.	**L1,L2, L3, L4**
MODULE -2	
PROJECT MANAGEMENT:Introduction – Meaning – nature and characteristics of Management, Scope and functional areas of Management – Management as a Science, Art or Profession Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – Early Management Approaches – Modern Management Approaches	**L1,L2, L3,L4**
MODULE -3	
PLANNING: Nature, importance and purpose of planning, process objectives – Types of plans (Meaning only) – Decision making – Importance of planning – steps in planning & planning premises – Hierarchy of plans	**L2, L3, L4**
MODULE -4	
ORGANIZING AND STAFFING: Nature and purpose of organization - Principles of organization – Types of organization - Departmentation – Committees – Centralization Vs decentralization of authority and responsibility – Span of control – MBO and MBE (Meaning only) Nature and importance of Staffing – Process of Selection & Recruitment (in brief).	**L2,L3,L4**
MODULE – 5	
DIRECTING & CONTROLLING: Meaning and nature of directing-Leadership styles, Motivation Theories, Communication – Meaning and importance –Coordination, meaning and importance and Techniques of Coordination. Meaning and steps in controlling – Essentials of a sound control system –Methods of establishing control	**L1, L2, L3**

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles and applications of Project Management

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Beenet P Lientz, Kathyn, Project Management – for 2 1st Centrury- Academic Press, 1995
2. Martin Grossmann Entrepreneurship in Biotechnology: managing for growth from startup to initial public offering. Verlag. Springer-2003
3. HolgerPatzelt and Thomas Brenner. Handbook of Bioentrepreneurship By Springer 2008
4. Graham Dutfield, IPR, Trade and Biodiversity, Earthscan publications, 2000

REFERENCE BOOKS

1. Damian Hine, John Kapeleris. Innovation and entrepreneurship in biotechnology, an international prospective. By Edward Elgar Publishing. 2006
2. P. S. Teng. Bioscience entrepreneurship in Asia: creating value with biology. By World scientific publishing. Co. Pte. Ltd. 2008
3. A.K. Singh. Entrepreneurship Development and Management by Firewall Media, 2006
4. Ramachandran, Entrepreneurship Development by. Tata McGraw-Hill Education, 2008

QC, QA & VALIDATION

[As per Choice Based credit System (CBCS) Scheme

SEMESTER – III

Subject Code	**18BBT332**	**CIEMarks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable studentsto:

- Appreciate the Basic concepts of Quality Control and Validation techniques for Biotechnology product development.
- To understand and apply the different QC and QA methodologies

Modules	RBT Level
MODULE 1	
QUALITY CONTROL AND ASSURANCE TECHNIQUE: Introduction, Basis concepts of Quality:- Developing quality culture. Quality Assurance General Concepts: Definition of quality assurance concept and components of Q. A., Concept of Quality control, Quality control of Biological products: International Biological standards, safety testing of pharmaceutical Quality control of antibiotics. International, Japanese, British and Indian pharmacopeias. Current GMP in manufacturing, processing, packaging of drugs. GMP for finished products	L1, L2, L3, L4
MODULE 2	
GOOD LABORATORY PRACTICE: Current GLP in manufacturing, responsibilities. General provision, organization and personnel, building and facilities, equipment, control of components and drug product, laboratory and control of records and reports, Non-clinical testing, Controls on animal house, Application of Computers in Quality control Laboratory	L1, L2, L3, L4
MODULE 3	
MANUFACTURING OPERATIONS AND CONTROL: Revised schedule M, sanitation of manufacturing premises, Mix –ups and cross contamination, processing of intermediates and Bulk product, Packaging operations, I.P.Q.C., Release of finished products process deviations, Drug product inspection, expiration dating, Document and formats, Specification, Master production and control record, Batch production and control record Significance of SOPs and record, change control, Drug Master file	L1, L2, L3
MODULE 4	
INTRODUCTION TO PHARMACEUTICAL VALIDATION: Definition, Manufacturing Process Model, Government regulation, scope of Validation, Advantage of Validation, Organizations for Validation, Validation Master plan, URS, D.Q., IQ, OQ & P.Q. of facilities. **,** General principles of analytical method validation, Validation of HPLC , Dissolution test apparatus Process Validation **:** Prospective, concurrent, retrospective & revalidation, Process validation of formulations. Validation of Pharmaceutical Water System & pure steam, Validation of HAVC system, Validation of Compressed air, Cleaning of Equipment, Cleaning of Facilities,Vendor Certification	L1, L2, L3
MODULE 5	
DRUG REGULATORY AFFAIRS: Harmonization of regulatory requirements including ICH activity. Regulatory requirements of different regions applicable to pharmaceutical developments, manufacturing, quality control on finished products, extended release products, biopharmaceutical and bioequivalence assessment and good	L1, L2, L3

clinical practices and Comparison with regulation in India. Filing of INDA, NDA and ANDA for approval and registration	

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in principles of QA and QC □
- Demonstrate the ability to use validation techniques and tools for product development.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Pharmaceutical Quality Assurance, MA Potdar, NiraliPrakashan, Pune
2. Validation of Pharmaceutical process, F. J. Carleton and J. Agalloco, Marcel Dekker Inc.
3. Pharmaceutical Process Validation, Second Ed., Ira R. Ferry & Robert Nash., Marcel Dekker Inc.
4. Quality Planning & Analysis by J. M. Juran and F. M. Gryna, Tata Mcgraw Hill, India.
5. Improving Quality through Planned experimentation by Moen, Tata Mcgraw Hill.

REFERENCE BOOKS

1. Good Manufacturing Practices for Pharmaceutical; A Plan for total Quality Control, 4th Ed, Sidney willing.
2. Quality Assurance Guide by Organization of Pharmaceutical producers of India.
3. Pharmaceutical Process Validation; By F. R., Berory and Robert A. Nash
4. Impurities Evaluation of Pharmaceutical; SatinderAhiya Marcel Decker.

ENTREPRENEUR DEVELOPMENT [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – III			
Course Code	**18BBT333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: The course will enable the students

- Appreciate the Basic concepts of entrepreneur development
- Apply the proof-of-concepts to Large scale and Entrepreneurship opportunities

Modules	**Revised Bloom's Taxonomy(RBT) Level**
MODULE -1	
ENTREPRENEURSHIP-ENTERPRISE: Conceptual issues. Entrepreneurship vs. Management. Roles andfunctions of Entrepreneur in relation to the enterprise and in relationto the economy. Entrepreneurship is an interactive process betweenthe individual and the environment. Small business as seedbed ofEntrepreneurship. Entrepreneur competencies, Entrepreneurmotivation, performance and rewards.	**L1,L2, L3, L4**
MODULE -2	
OPPORTUNITY SCOUTING AND IDEA GENERATION: Role of creativity and innovation and business research. Sources ofbusiness ideas. Entrepreneur opportunities in contemporary businessenvironment, for example opportunities in net-work marketing,franchising, business process outsourcing in the early 21st century.The process of setting up a small business: Preliminary screeningand aspects of the detailed study of the feasibility of the businessidea and financing/non-financing support agencies to familiarizethemselves with the policies/programs and procedures and theavailable schemes. Preparation of Project Report and Report onExperiential Learning of successful and unsuccessful entrepreneurs	**L1,L2, L3,L4**
MODULE -3	
MANAGEMENT ROLES AND FUNCTIONS IN A SMALL BUSINESS: Designing and re-designing business process, location, layout, operations planning and control. Basic awareness on the issues impinging on quality, productivity and environment. Managing business growth. The pros and cons of alternative growth options: internal expansion, acquisitions and mergers, integration and diversification. Crisis in business growth.	**L2, L3, L4**
MODULE -4	
PRINCIPLES OF DOUBLE-ENTRY BOOK KEEPING: Journal entries, cash-book, pass book, and Bank Reconciliation	**L2,L3,L4**

Statement, ledger accounts, trail balance and preparation of final accounts: Trading and Profit and Loss Account; Balance-sheet. Brief introduction to Single-Entry system of record keeping. Sources of risk/venture capital, fixed capital, working capital and a basic awareness of financial services such as leasing and factoring.	
MODULE – 5	
ISSUES IN SMALL BUSINESS MARKETING:	
The concept and application of product life cycle, advertising and publicity, sales and distribution management. The idea of consortium marketing, competitive bidding/tender marketing, negotiating with principal customers. The contemporary perspectives on Infrastructure Development, Product and Procurement Reservation, Marketing Assistance, Subsidies and other Fiscal and Monetary Incentives. National state level and grass-root level financial and non-financial institutions in support of small business development	**L1, L2, L3**

Course outcomes: At the end of the course the graduates should be able to

- Demonstrate strong basics in entrepreneurship
- Demonstrate the ability to manage industrial projects and develop products

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20marks.
- Eachfullquestioncanhaveamaximumof4subquestions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from eachmodule.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

TEXT BOOKS

1. Brandt, Steven C., "The 10 Commandments for Building a Growth Company",Macmillan Business Books, Delhi, 3rd Ed., 1977.
2. Bhide, Amar V., "The Origin and Evolution of New Business", Oxford University Press, New York, 2000.
3. Dollinger M.J., "Entrepreneurship strategies and Resources", Pearson Education, New Delhi, 3rd Ed., 2006.
4. Desai, Vasant Dr., "Management of small scale enterprises", Himalaya Publishing House, 2004.
5. Taneja, Gupta, "Entrepreneur Development New Venture Creation", Galgotia Publishing Company, 2nd Ed., 2001.

REFERENCE BOOKS

1. Patel, V.G., "The Seven Business Crises and How to Beat Them", TMH, 1995.
2. SIDBI Report on Small Scale Industries Sector [latest edition]
3. Verma, J.C. and Gurpal Singh, "Small Business and Industry-A Handbook for Entrepreneurs", Sage, New Delhi, 2002.
4. Manohar, "Entrepreneurship & Management", Wiley India, 2012.

EVALUATION OF PROJECT PHASE -1 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Sub. Code :	18BBT34	CIE Marks :	100
Hours/week :	2	Exam Hrs. :	-
Total Hours :	25	Exam Marks :	-
CREDITS – 02			

INTERNSHIP [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Sub. Code :	18BBTI35	CIE Marks :	40
Hours/week :	-	Exam Hrs. :	3
Total Hours :	-	SEE Marks :	60
CREDITS – 06			

PROJECT WORK PHASE -2 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Sub. Code :	18BBT41	CIE Marks :	40
Hours/week :	-	Exam Hrs. :	3
Total Hours :	-	SEE Marks :	60
CREDITS – 20			