Bachelor of Engineering

(Biotechnology)

(Four Year Full Time Degree Program)

SYLLABUS

B. Tech. (Biotechnology) Third & Fourth Year

School of Biotechnology

Shri Mata Vaishno Devi University, Katra

(May 2018)

	ABBREVIATIONS / CODES / NOMENCLATURE
Course Code Convention	
SCTLBSC Example: BTL3181 BTL3261	Course Code for various Courses / Subjects SC: School Code T: Course Type Code (Lecture/Practical/Colloquium/Project, etc.) L: Course Level (1, 2, 3 & 4 for First, Second years …) B: Broad Study Area S: Sub Area C: Course Specific Code Number
BT	School Code (SoBT)
L	Lecture
P	Practical
T	Tutorial
C	Colloquium
E	Elective
C	Colloquium
D	Project Based
NC	Non Credit
Teaching Scheme Convention	
L	Lecture
T	Tutorial
P	Practical
C	Course Credit
Evaluation Scheme Convention	
Minor	(Mid Term Exams / Tests) I & II
Major	Semester End Examination (Major)
FFCS	Fully Flexible Credit System
CBCS	Choice Based Credit System

B. Tech. (Biotechnology), Semester - V (Fall), THIRD Year													
			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	**Subject Code**	**Title of the Subject**	**L**	**T**	**P**	**Total Periods /week**	**C**	**Minor Duration (Hours)**	**Major Duration (Hours)**	**Internal Marks**	**Minor Marks (I + II)**	**Major Marks**	**Total Marks**
1	BTL3181	Immunology	3	0	0	3	3	1.5	3	10	40	50	100
2	BTL3271	Enzyme Engineering and Technology	3	0	0	3	3	1.5	3	10	40	50	100
3	BTL3151	Recombinant DNA Technology	3	0	0	3	3	1.5	3	10	40	50	100
4	BTL2252	Transport Process II	3	0	0	3	3	1.5	3	10	40	50	100
5	XXEXXXX	Open Elective - III	3	0	0	3	3	1.5	3	10	40	50	100
6	BTE3XXX	School Elective - II (2 choices)	3	0	0	3	3	1.5	3	10	40	50	100
7	BTP3184	Immunology Lab	0	0	3	3	1.5	-	-	-	-	100	100
8	BTP3274	Enzyme Engineering and Technology Lab	0	0	3	3	1.5	-	-	-	-	100	100
9	BTP3154	Recombinant DNA Technology Lab	0	0	3	3	1.5	-	-	-	-	100	100
		SUBTOTAL	**18**	**0**	**9**	**27**	**22.5**	**-**	**-**	**60**	**240**	**600**	**900**
	NOTE	Marks for Lab courses shall be awarded on the student's work in the form of a written test along with experimental performance, viva voce and continuous evaluation methods which shall be evaluated by the concerned Course Coordinators.											

B. Tech. (Biotechnology), Semester - VII (Fall), FOURTH Year													
			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	**Subject Code**	**Title of the Subject**	**L**	**T**	**P**	**Total Periods /week**	**C**	**Minor Duration (Hours)**	**Major Duration (Hours)**	**Internal Marks**	**Minor Marks (I + II)**	**Major Marks**	**Total Marks**
1	BTL4262	Instrumentation and Process Control	3	0	0	3	3	1.5	3	10	40	50	100
2	BTL4263	Bioprocess Plant Design	3	1	0	4	4	1.5	3	10	40	50	100
3	BTL4301	Environmental Biotechnology	3	0	0	3	3	1.5	3	10	40	50	100
4	BTL4411	IPR and Biosafety	3	0	0	3	3	1.5	3	10	40	50	100
5	BTC4311	Colloquium				3	1.5	-	-	-	-	-	100
6	BTP4302	Environmental Biotechnology Lab	0	0	3	3	1.5	-	-	-	-	100	100
7	BTE4XXX	School Elective - IV (3 choices)	3	0	0	3	3	1.5	3	10	40	50	100
8	XXEXXX	Open Elective - V	3	0	0	3	3	1.5	3	10	40	50	100
		SUBTOTAL	**18**	**1**	**3**	**25**	**22**	**-**	**-**	**70**	**280**	**450**	**800**
	NOTE	Marks for Lab course shall be awarded on the student's work in the form of a written test along with experimental performance, viva voce and continuous evaluation methods which shall be evaluated by the concerned Course Coordinator/s.											
		Marks for Colloquium course shall be awarded on the student's work in the form of a Reports/Presentations/Seminars/Viva voce methods or all of them for the Practical Training taken during the Summer Vacation after Semester VI which shall be evaluated by the concerned Course Coordinator/s.											

LIST OF PROGRAM ELECTIVES (For School Elective - II For Sem V)							
1	BTE3042	Biochemistry II	3	0	0	3	
2	BTE3351	Stem Cell Technology	3	0	0	3	
LIST OF PROGRAM ELECTIVES (For School Elective - IV For Sem VII)							
1	BTE4401	Biopharmaceutics and Pharmacokinetics	3	0	0	3	
2	BTE4425	Principles in Research Methodology	3	0	0	3	
3	BTE4177	Recent Advances in Biotechnology	3	0	0	3	

NOTE:
Elective Courses shall be offered on the basis of the choice of the course given by the students, available faculty expertise and resources at that time subject to minimum 10 % students of a particular batch.

Third Year

Vth Semester

BTL 3181			**Immunology**				**Pre Requisites**		**Principles of Modern Biology BTL1011**	
Version R-01							Co-requisites		Nil	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3		3	4.5	1.5 Hrs	3 Hours	10	20	20	150	200

Course Contents:-

Unit-I: **The Basis of Immunology** (8 Contact Periods)

Immune system- an overview; humoral and cell mediated immunity; Cells and molecules of immune system; Primary and secondary lymphoid organ; Innate immunity; Macrophages and dendritic cells; Complement. **[CO1]**

Unit-II: **B Cells and Antibody** (8 Contact Periods)

Antigen; B cells and antibody; Synthesis of antibody and secretion; Molecular basis of antibody diversity; Polyclonal and monoclonal antibodies, hybridoma technology; Antigen-antibody reactions; Immunological techniques, RIA/ELISA, Flow cytometry. **[CO2]**

Unit-III: **MHC Molecules and T Cells** (8 Contact Periods)

MHC structure and function; Antigen processing and presentation; T cells, T cell activation and differentiation, T Cell mediated immunity. **[CO3]**

Unit-IV: **Clinical Immunology** (12 Contact Periods)

Hypersensitivity; Autoimmunity and immune tolerance; Regulation of immune response; Transplantation and rejection, graft versus host reaction; Tumor immunology; Vaccines. **[CO4]**

Unit-V: **List of Experiments [CO1 & CO2]** (12 Contact Periods)

1. Separation of blood plasma and serum
2. Analysis of blood cells
3. Isolation of peripheral blood mononuclear cells
4. To learn the technique of Ouchterlony double diffusion
5. To learn the technique of single radial diffusion for the quantitative estimation of antigen
6. To learn the technique of rocket immunoelectrophoresis for the quantitative estimation of antigen
7. To learn the technique of immunoelectrophoresis.
8. To perform blood typing
9. To perform widal test
10. Purification of IgG
11. SDS-PACE of IgG
12. To learn the Western Blotting (Immunoblot) technique
13. To perform ELISA.

Recommended Books:-

1. Kuby Immunology, 7th Edition, Judith AO, Jenni P, Sharon AS & Freeman WH, 2013.
2. Immunology-A Short course, 6th Edition, Coico R & Sunshine G, Wiley-Blackwell, 2009.
3. Fundamentals of Immunology, 7th Edition, Paul WE, Williams L & Wilkins, 2013.
4. Cell and Molecular Immunology, 7th Edition, Lichtman A & Pillai, Elsevier, 2011.
5. Janeway'sImmunobiology, 8th Edition, Murphy K & Science G, Taylor and Francis, 2011.

6. A Handbook of Practical Immunology, Talwar GP.
7. Practical Immunology, 4th Edition, Hay UK & Westwood FC, Blackwell Sciences, 2002.

Course Outcomes:-

After successful completion of this course, students will be able to;

1. Give an overview of immune system; describe the components of immune system, understand complement and innate immune system.
2. Understand B cell development and activation; antibody related various aspects and common applications of antibody.
3. Understand the MHC molecules and their function, process of antigen processing and antigen presentation; T cell development, activation, differentiation and role of T cells.
4. Understand the key players, mechanisms and therapeutic/preventive interventions in the states of health and disease.

Vth Semester

BTL3271				**Enzyme Engineering and Technology**			**Pre Requisites**		**Biochemistry I BTL1041**	
							Co-requisites		Microbiology BTL1071	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	3	4.5	1.5 Hrs	3 Hrs	10	20	20	150	200

Course Objectives:-

1. To learn nomenclature and classification of enzymes as per international organization.
2. To have an overview on application of enzymes in industries, medicine and their therapeutic use or diagnostic use.
3. To learn mechanism of action of enzymes in biological reactions.
4. To learn techniques for purification of protein of interest from microbial sources.
5. To learn techniques of immobilization of whole cell and enzyme entrapment.
6. To learn kinetics of enzymes in single substrate and mutlisubstrate reactions

Course Contents:-

Unit-I Introduction to Enzymes: (9 Contact Periods)

Introduction & scope; general distinctive features and industrial applications; enzyme kinetics: Single, substrate steady state kinetics; King-Altman‘s method. **[CO1 & CO4]**

Unit-II Mechanism of Enzyme Action: (9 Contact Periods)

Multi-substrate systems; effect of pH and temperature; allosteric enzymes micro-environmental effects; inhibitors and activators. **[CO1, CO5 & CO6]**

Unit-III Methods of Immobilization: CO 3 & 2 (9 Contact Periods)

Immobilization of enzymes: advantages; carriers; adsorption; covalent coupling; cross linking and entrapment methods. **[CO2, & CO3]**

Unit-IV Bioreactors and Immobilized Enzymes: C O 2 & 6 (9 Contact Periods)

Enzyme reactors, Bio-operational strategies; A few case studies on Immobilized cells; challenges and Future trends. **[CO2 & CO6]**

Unit-V Laboratory Experiments (36 Contact Periods)

1. Introduction to Enzymology lab, basic practices & equipment usage.
2. Qualitative test for enzyme assay (plate assay method)
3. Assay of enzyme activity.
4. Influence of substrate concentration on the rate of enzymatic reaction.
5. Effect of pH on the rate of enzyme reaction.
6. Effect of temperature on the rate of enzyme reaction.
7. To study kinetics of enzyme catalyzed reaction.
8. Entrapment of enzyme in alginate Beads.
9. To study the kinetics of the rate of enzymatic reaction by enzyme entrapped alginate beads.
10. Isolation and purification of enzyme.

Recommended Books:-

1. Enzymes, Biochemistry, Biotechnology, Clinical chemistry: Palmer T, Philip L & Booner.
2. Enzyme Technology, Pandey A, Asia Tech Publishers.
3. Fundamentals of Enzymology, Price N, Oxford University Press.
4. Practical Enzymology, Bisswanger H.
5. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K & Walker J.
6. Enzyme Assays: A Practical Approach, Eisenthal R & Danson M.
7. Enzyme Stabilization and Immobilization: Methods and Protocols, Minteer SD.

Course Outcomes:-

After successful completion of this course, students will be able to:
1. Classify enzymes depending upon the reaction mechanism followed.
2. Isolate enzymes from microbial sources.
3. Explain the process of immobilization of enzymes and whole cell entrapment.
4. Explain the role of enzymes in medicine as therapeutic use or diagnostic use.
5. Explain role of enzymes in maintaining cell activity.
6. Purify enzymes using chromatographic techniques.

Vth Semester

BTL 3151			**Recombinant DNA Technology**				**Pre Requisites**		**Molecular Biology and Genetics BTL2131**	
Version R-01							Co-requisites		**Nil**	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	3	4.5	1.5 Hrs	3 Hrs	10	20	20	150	200

Course Contents:-

Unit-I Basics of Recombinant DNA Technology (15 Contact Periods)

Introduction to r-DNA technology; vectors: definition and types; construction and properties of plasmid, phage, cosmid and phagmid vectors; restriction enzymes and other enzymes, properties and uses in cloning;restriction mapping.

Unit-II Construction and Screening of DNA libraries (18 Contact Periods)

Transformation – the uptake of DNA by bacterial cells. Identification of recombinants. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into non-bacterial cells. Construction of genomic and c-DNA libraries, chromosome walking; Screening of libraries.

Unit-III Sequencing and Amplification of DNA (12 Contact Periods)

DNA amplification through PCR: Basic features and applications of PCR, types and modifications. Real-time PCR/qPCR, DNA sequencing; Maxam Gilbert's and Sanger dideoxy chain termination and automated methods of DNA sequencing.

Unit-IV: Expression of Recombinant Proteins (8 Contact Periods)

Expression of genes in recombinant cells; stability of recombinant cells in the production of biochemical's and therapeutic proteins

Unit-V: List of Experiments:- (14 Contact Periods)

1. Isolation and purification of eukaryotic chromosomal DNA
2. Isolation and purification of Prokaryotic DNA
3. Isolation and purification of Plasmid DNA from *E. coli*
4. Partial and complete Restriction Digestion of Genomic DNA
5. Restriction digestion of plasmid DNA and purification
6. Demonstration of Ligation reaction on gel electrophoresis
7. Preparation of competent cells of *E. coli*
8. Transformation of the competent cells
9. Construction of genomic library in *E. coli*
10. Amplification of DNA using PCR
11. Sequencing overview
12. Determination of plasmid copy number and stability
13. Demonstration of promoter activity using expression construct
14. SDS PAGE analysis of the expressed protein

Recommended Books:

1. Gene Cloning and DNA analysis: An Introduction, 7th Edition, Brown TA, Wiley-Blackwell, 2016.
2. Principles of Gene Manipulation and Genomics, 7th Edition, Primrose SB & Twyman R, Wiley-Blackwell, 2006.
3. Recombinant DNA: Genes and Genomes: A Short Course, Watson JD, Myers RM, Caudy AA & Witkowski JA, WH Freeman Publishers, 2007.
4. Gene Cloning, Lodge J, Lund P & Minchin S, Taylor & Francis, 2006.

5. An Introduction to Genetic Engineering, 3rd Edition Nicholl DST, Cambridge University Press, 2008.
6. Molecular Cloning: A Laboratory Manual, 4th Edition, Sambrook J & Russell DW, Cold Spring Harbor Laboratory Publishers, 2012.
7. Current Protocols in Molecular Biology, Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K, John Wiley & Sons Inc., 2003.
8. Molecular Cloning: A Laboratory Manual, 2nd Edition, Sambrook J, Fritsch EF & Maniatis T, Cold Spring Harbor Laboratory Publishers, 1989.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Understand basic principles of recombinant DNA technology;
2. Understand gene cloning methods and the tools and techniques involved in gene cloning.
3. Construct cDNA and genomic DNA libraries for the isolation of genes
4. Devise cloning strategies for DNA and PCR products
5. Discuss the applications of PCR and DNA sequencing
6. Construct recombinant DNAs suitable for expression
7. Understand purification of recombinant proteins in *E. coli* and yeast

Vth Semester

BTL 2252			**Transport Process -II**				**Pre Requisites**		**Nil**	
Version R-01							Co-requisites		Chemical Engineering Thermodynamics BTL3261	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3 Hrs	10	20	20	50	100

Course Content:-

Unit-I Mode of Heat Transfer: (9 Contact Periods)
Heat transfer principles; Conduction, Convection and Radiation

Unit-II Heat Exchangers and Design: (9 Contact Periods)
Heat exchangers; overall heat transfer coefficients; LMTD; analysis of heat exchangers; jacketed vessels; heat exchanger coils.

Unit-III Unit Operations and Heat Involved: (9 Contact Periods)
Boiling and condensation; Condensers and evaporators. Humidification operations; design of cooling towers. Drying of solids; design of batch and continuous dryers.

Unit-IV Oxygen Mass Transfer: (9 Contact Periods)
Empirical correlation based on analogy between momentum, heat and mass transfer; Oxygen mass transport.

Recommended Books:-

1. Unit operations of Chemical Engineering, McCabe W, Smith J & Harriott P, McGraw Hill Publishers.
2. A Heat Transfer Textbook, John H Lienhard IV & John H Lienhard V, Phlogiston Press, Cambridge Massachusetts.

Course Outcomes:-

After successful completion of this course, students shall be able to:

1. Understand the basic principles of heat transfer and will be able to analyze the heat involved with the different phenomena of conduction convection and radiation.
2. Learn about heat exchangers, design, analysis and calculation of heat transfer through them.
3. Understand the different process boiling, condensation, drying, cooling, evaporation, humidification operations and the equipments used for the same.
4. Learn the basic mass transfer mechanism and the oxygen mass transport involved with aerobic fermentation.

Vth Semester

BTE3042			**Biochemistry II**				**Pre Requisites**		**Biochemistry I BTL1041**	
Version R-01							Co-requisites		Enzyme Engineering Technology	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5	3 Hrs	10	20	20	50	100

Course Contents:-

Unit-I: Biosynthesis and Degradation of Biomolecules (12 Contact Periods)
Catabolism of amino acids and nucleotides; biosynthesis of amino acids, lipids, nucleotides and their control **[CO1 & CO2]**

Unit-II: Metabolism and Energy Cycle of Life (5 Contact Periods)
Integration of metabolism; protein degradation and turnover; protein targeting. **[CO3]**

Unit-III: Regulation and Signalling Processes of Biomolecules (10 Contact Periods)
Allosteric transitions and regulation; Signal transduction. **[CO4]**

Unit-IV: Cellular Metabolic Integration with Relevance to Life Processes (12 Contact Periods)
Receptors and hormones; antigen-antibody relationship. **(CO4 & CO5)**

Recommended Books:-

1. Lehninger's Principles of Biochemistry, 5th Edition, David LN & Cox MM,WH Freeman & Co.
2. Biochemistry, 5th edition, Garrett RH & Grisham CM, Brooks Cole Cengage Learning.
3. Biochemistry, 6th edition, Jeremy MB, John LT & Lubert S, WH Freeman & Co.
4. Harper's Illustrated Biochemistry, 30th Edition, Robert KM, Darryl KG, Peter AM & Victor WR.

Course Outcomes:-

After successful completion of this course, students will be able to;

1. Describe the characteristics of synthesis and degradation of biomolecules.
2. Understand the various metabolic processes and how energy produced, precursors and intermediates are recycled.
3. Evaluate the processes of metabolic regulation for various biological functions and energy utilization in different organisms
4. Describe the types of signal transduction mechanisms in living organisms with examples.
5. Understand the various processes of cellular metabolic regulation and its relevance to biochemical conversions in living organisms.

Vth Semester

BTE 3351			**Stem Cell Technology**				**Pre Requisites**		**Principles of Modern Biology (BTL1011)**	
Version R-01							Co-requisites		Nil	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5	3 Hours	10	20	20	50	100

Course Contents:-

Unit-I: **Types of Stem Cells** (9 Contact Periods)

Early events in development; Introduction to stem cells and basis of stemness; Types & sources of stem cell with characteristics. **[CO1]**

Unit-II: **Stem Cells Isolation and Culture** (5 Contact Periods)

Isolation, characterization and maintenance of embryonic stem cell isolated from: Mouse and Human. Serum and feeder free culture of human embryonic stem cells, evolution of xeno-free culture systems. **[CO2]**

Unit-III: **Basic biology/Mechanisms of Stem Cells** (10 Contact Periods)

Basic biology of stem cells: basis of pluripotency and mechanisms of stem cell self-renewal, stem cell niche. **[CO3]**

Unit-IV: **Applications of Stem Cells** (12 Contact Periods)

Applications of stem cells in diseases, injury and gene therapy. Ethical and regulatory issues of stem cells. **[CO4 & CO5]**

Recommended Books:-

1. Handbook of Stem Cells, 2nd Edition, Atala A & Lanza R, Academic Press, 2012.
2. Essential of Stem Cell Biology, 3rd Edition, Lanza R, et al, Elsevier Academic Press, 2013.
3. Translational Approaches in Tissue Engineering & Regenerative Medicine, Mao JJ, et al, Artech House, 2007.
4. Stem Cell Repair and Regeneration, Volume-2, Habib NA, Levièar NY, Gordon M, Jiao L & Fisk N, Imperial College Press, 2007.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Describe the characteristics of stem cells and the different types of stem cells.
2. Understand the isolation process and cultivation of embryonic stem cells.
3. Understand basic biology/mechanisms of pluripotency and self-renewal of stem cells, and stem cell niche.
4. Describe the applications of stem cells in diseases, injury and gene therapy.
5. Appreciate the ethical and regulatory issues associated with use of stem cells.

Fourth Year

VIIth Semester

BTL 4262				**Instrumentation and Process Control**			**Pre Requisites**		**Bioprocess Engineering BTL2233**	
Version R-01							Co-requisites		Bioprocess Technology BTL2232	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3 Hrs	10	20	20	50	100

Course Contents:-

Unit-I Dynamics of First and Second Order Control Systems: (12 Contact Periods)
Laplace transformation, transformation of standard function, firstorder systems, transient response, input functions, linearization, first and second order system and dynamics, transfer functions of bioreactor and dynamics. **[CO1 & CO3]**

Unit-II Controllers and Control Elements (12 Contact Periods)
Open loop and closed loop control system, controller mechanism, introduction to advance control systems, feed forward control, block diagram, Transfer functions for controllers. Transient response, lag, application in bioprocess control. **[CO2, CO3 & CO4]**

Unit-III Instrumentation (12 Contact Periods)
Principles of measurement and classification of process control instruments, a few examples of controlling of parameters, online analysis of and computer control of fermentation processes, Introduction to biosensors, Characteristics of biosensors, Microbial biosensors. **[CO5 & CO6]**

Recommended Books:-

1. Instrumentation, Measurement and Analysis, Nakra BC & Chaudhary KK, Tata McGraw-Hill, New Delhi.
2. Process System Analysis and Control, Coughnowr DR, McGraw Hill International.
3. Bioprocess Engineering Principles, Doran PM, Academic Press, California.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Acquire knowledge of phase plane, Laplace domain, and frequency domain analysis of nonlinear distributed and multivariable systems for dynamic behavior and stability.
2. Understand about controller, types of controller used for specific problems in chemical industry design.
3. Explain the basic principles & importance of process control in industrial process plants;
4. Explain the use of block diagrams & the mathematical basis for the design of control systems;
5. Apply instrumentation principles to specify industrial instruments, sensors and actuators
6. Explain the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants.

VIIth Semester

BTL 3241			**Bioprocess Plant Design**				**Pre Requisites**		**Chemical Reaction Engineering BTL3261**	
Version R-01							Co-requisites		Bioprocess Engineering BTL2233	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hrs	3 Hrs	10	20	20	50	100

Course Contents:-

Unit-I Introduction to Bioprocess Plant Design: (12 Contact Periods)

Introduction; general design information; mass and energy balance; flow sheeting; piping and instrumentation; materials for construction of bioprocess plants. **[CO1]**

Unit-II Criteria in Vessel and Equipment Designing (12 Contact Periods)

Mechanical design of process equipment; vessels for biotechnology application; design of fermenters; design considerations for maintaining sterility of process streams processing equipment; selection and specification of equipment for handling fluids and solids. **[CO2]**

Unit-III Design of Heat Transfer Equipments (12 Contact Periods)

Selection, specification design of heat and mass transfer equipments used in bioprocess industries; design of facilities for cleaning of process equipment used in biochemical industries. **[CO3]**

Unit-IV Process Hazards and Safety Considerations: (12 Contact Periods)

Utilities for biotechnology production plants; process economics; bioprocess validation; safety considerations; case studies. **[CO4]**

Recommended Books:-

1. Perry's Chemical Engineers Handbook, Perry RH & Green DW, 7th Edition, McGraw Hill Book Co.
2. Bioprocess Engineering: Basic Concepts, 2nd Edition, Shuler M & Kargi F, Prentice Hall, Englewood Cliffs, NJ, 2002.
3. Bioseparations Science and Engineering, Harrison R et al., Oxford University Press, 2003
4. Chemical Engineering, Volume 6: An Introduction to Chemical Engineering Design, 2nd Edition, Coulson JM & Richardson JF, Butterworth-Heinemann Ltd.
5. Process Equipment Design, 3rd Edition, Joshi MV & Mahajani VV, Macmillan India Ltd.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Learn the procedures for plant location, preparing the layout of plants, the storage methods and the materials handling in the industry.
2. Understand the material and energy balances in the process analysis, environmental regulations in setting up a plant.
3. Familiarize the configurations of the bioreactors.
4. Estimate the overall cost of the plant, analyze safety considerations and perform bioprocess validation.

VIIth Semester

BTL4301			**Environmental Biotechnology**				**Pre Requisites**		**Microbiology BTL1071**	
Version R-01							Co-requisites		Bioprocess Technology BTL2232	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	3	4.5	1.5 Hrs	3 Hrs	10	20	20	150	200

Course Objectives:-

1. The course outlines the principles of methods for quantification of organic carbon in wastewater.
2. It helps to explain the microbial processes and growth requirements underlying the activated sludge process.
3. Students will be able to evaluate the potential for biodegradation of organic pollutants and alternative process schemes for combined biological nutrient removal (BNR).

Course Contents:-

Unit-I Characteristics of Wastes: (9 Contact Periods)

Waste and its sources; physical, chemical and biological characteristics of waste water; estimation and correlation of BOD, COD and TOC of wastewater. BOD progression curve and kinetics. **[CO1 & CO2]**

Unit-II Primary and Secondary Treatment of Waste: (9 Contact Periods)

Determination of BOD rate constants; effect of temperature, moisture and microorganismss on BOD; primary treatment of waste water, secondary treatment of wastewater like activated sludge process (ASP); biological solid retention time; sludge volume index (SVI); relation between recycle ratio and biological solid retention time in ASP; Aeration systems in ASP; step-aeration; extended aeration; contact stabilization. **[CO2, CO3 & CO4]**

Unit-III Kinetic Parameters and Solid Waste Management: (9 Contact Periods)

Evaluation of kinetic parameters in ASP; Nitrification and biological denitrification in ASP; Anaerobic treatment of wastes; Attached growth of biological treatment process; Trickling filter; Sludge and its characteristics; Sludge digestion i.e Aerobic and Anaerobic digestion. **[CO4 & CO5]**

Unit-IV Biodegradation and Bioremediation: (9 Contact Periods)

The scope of environmental biotechnology; Biodegradation of macromolecules. Heavy metal pollution; Bioremediation of metal contaminated soils, spilled oil and grease deposits and synthetic pesticides. Biosensors to detect environmental pollutants. **[CO6]**

Unit-V Environmental Biotechnology Lab (36 Contact Periods)
List of Experiments:- **[CO6]**

1. Determination of total solids in waste water.
2. Determination of total organic solids in waste water.
3. Determination of DO, BOD, COD in water samples.
4. Physico-chemical characterization of waste water.
5. Microbiological characterization of waste water.

Recommended Books:-

1. Environmental Science and Technology, Manahan, SE, Lewis, New York.

2. Wastewater Engineering: Treatment and Reuse, Metcalf and Eddy (Eds), Tata McGraw-Hill, New Delhi.
3. Genetically Modified Organisms in Agriculture: Economics and Politics, Nelson GC, 2001, Academic Press.
4. Environmental Biotechnology: Theory and Application, Evans GM & Furlong JC, 2003, John Wiley & Sons.
5. Biotechnology and Safety Assessment, Thomas JA & Fuchs R, 2002, Academic Press.
6. Advanced, Physicochemical Treatment Processes, Wang LK, Hung YT & Shammas NK (Eds), 2006, Springer-Verlag New York.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Differentiate between several types of waste and understand the properties of wastewater.
2. Outline the principles of methods for quantification of organic carbon and oxygen demand in wastewater.
3. Explain the primary and secondary treatment of wastewater.
4. Evaluate the potential for biodegradation of organic pollutants.
5. Evaluate the processes for digestion of sludge
6. Learn the techniques for bioremediation and biodegradation of various type of wastes.
7. Analyze the physico-chemical and biological characteristics of wastewater.

VIIth Semester

BTE4411				**IPR &Biosafety**			**Pre Requisites**		**Microbiology BTL1071**	
Version R-01							Co-requisites		Nil	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3 Hrs	10	20	20	50	100

Course Contents:-

Unit-I Introduction to Intellectual Property Rights: (6 Contact Periods)
Intellectual property, types of property rights, choice of intellectual property protection. **[CO1 & CO2]**

Unit-II Patenting Processes: (9 Contact Periods)
Patents, patent claims, legal decision making process, ownership of tangible and intellectual property; requirements of patentability, patentable subject matter, novelty and the public domain, non obviousness; patent litigation, procedural aspects of patent litigation, recent developments in patent system and patentability of biotechnological inventions; special issues in biotechnology patents, disclosure requirements. **[CO2 & CO3]**

Unit-III Harmonization of IPR Rights and case studies: (9 Contact Periods)
Collaborative research, competitive research, plant variety protection act, plant breeders rights; international conventions, WTO, GATT, TRIPs; case studies Rice, Haldi, Neem, Basmati. **[CO1, CO2, CO3]**

Unit-IV Biosafety Principles and Guidelines: (12 Contact Periods)
Biosafety concepts and issues: Rational vs subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biosafety levels, biosafety concerns at the level of individuals, institutions, society, region, country and the world; biosafety in the laboratory institution, laboratory associated infections and other hazards, prudent biosafety practices in the laboratory/institution; biosafety regulation in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad.
[CO4, CO5 & CO6]

Recommended Books:-

1. Handbook of Indian Patent Law and Practice, Viswanathan S, Printers and Publishers Pvt. Ltd., 1998.
2. Intellectual Property Rights: Critical Concepts in Law, Vaver D, Taylor & Francis, 2006.
3. Intellectual Property: A Reference Handbook, Aaron Schwabach, ABC-CLIO, 2011.
4. IPR, Biosafety & Bioethics, Goel D & Parashar S, Pearson Publishers, 2013.
5. Introduction to Biotechnology, Pathak R, Atlantic Publishers & Distributors (P) Ltd., 2007.
6. Biological Safety Principles & Practices, 4th Edition, Fleming DO & Hunt DL, ASM Press, 2006.

Course Outcomes:-

After successful completion of this course, students will be able to:
1. Describe the principles and choice for seeking various types of Intellectual Property Rights.
2. Identify the patentable and non-patentable materials.
3. Follow the correct procedures for filing of a patent.
4. Be aware of the principles and levels of Biosafety in Biotechnological research.
5. Be able to implement/design the proper containment facilities for a particular level of Biosafety in a given institution/industry.
6. Be aware about the various national and international guidelines of Biosafety.

VIIth Semester

BTC4311			**Colloquium**				**Pre Requisites**		Fifty (50) working days or 400 hours of practical training in an industry at the end of three years of study	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major* Marks	Total Marks
3	0		1.5						100	100

*Marks for Colloquium course shall be awarded on the student's work in the form of a Reports/Presentations/Seminars/Viva voce methods or all of them for the Practical Training taken during the Summer Vacation after Semester VI which shall be evaluated by the concerned Course Coordinator/s.

Course Contents:-

Unit-I Report Submission and Presentation: (12 Contact Periods)

Students shall submit the Project Report and deliver a Power Point Presentation batch-wise based on their work done during the summer training.

Unit-II Report Submission and Presentation: (contd.) (12 Contact Periods)

Students shall submit the Project Report and deliver a Power Point Presentation batch-wise based on their work done during the summer training.

Unit-III Viva Voce and Group Discussion: (12 Contact Periods)

The presentations and work done shall be reviewed for the whole class together during the group discussion.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Use correct form of scientific language.
2. Analyze and present appropriate research data generated by them.
3. Acquire hands-on training on ongoing fields of research.

VIIth Semester

BTE4401			**Biopharmaceutics and Pharmacokinetics**				**Pre Requisites**		**Biochemistry I BTL1041**	
Version R-01							Co-requisites		Nil	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3.0 Hrs	10	20	20	50	100

Course Contents:-

Unit-I Basics of Drug Delivery and Pharmacacokinetics (9 Contact Periods)
Introduction to Bio-pharmaceutics and Pharmacokinetics and their role in formulation development, Routes of drug delivery.

Unit-II Modes of Drug Absorption and Kinetics (9 Contact Periods)
Passage of drug across biological barrier, Pharmacokinetics of drug absorption (zero order, 1st order), Factors influencing absorption of drugs.

Unit-III Models of Drug Distribution, Termination of Drug Action (9 Contact Periods)
Drug distribution in the body, Compartment and non-compartment model, plasma protein binding, Volume of distribution and distribution coefficient. Termination of drug action, Excretion, Biotransformation, Tissue redistribution.

Unit-IV Pharmacokinetic Principles, Bioavailability and Drug Dose Calculation (9 Contact Periods)
Pharmacokinetic principles, Bioavailability and Bioequivalence, Measures of bioavailability, Pharmacokinetic parameters from plasma and urine data, C-max, and Area under curve (AUC), Calculation of LD50 & ED50, Therapeutic index, Dosage adjustment in patients with renal and hepatic failure.

Recommended Books:-

1. Text book of Biopharmaceutics & Clinical Pharmacokinetics, Niazi S, Appleton-Century-Crofts (ACC), New York.
2. Pharmacokinetics and Metabolism in Drug Design, Smith DA, Waterbeemd HVD & Walker DK, Wiley VCH.

Course Outcomes:-

After successful completion of this course, students shall be able to:

1. Understand the basics of drug delivery and different routes of drug delivery.
2. Learn about the role of the Biopharmaceutics and Pharmacokinetics and their role in formulation development.
3. Understand different rate of drug absorption and their kinetics.
4. Understand various phenomenon involved in drug absorption, distribution and elimination from the body.
5. Calculate various kinetic parameters required in dose calculation and adjustments.

VIIth Semester

BTE 4425			**Principles in Research Methodology**				**Pre Requisites** Co-requisites		**Nil**	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3 Hrs	10	20	20	50	100

Course Contents:-

Unit-I Introduction to Research and Research Methodology: (9 Contact Periods)
Research Methodology: An Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology.

Unit-II Defining and Designing of Research Plan: (9 Contact Periods)
Defining the Research Problem, Research Design, Important Concepts Relating to Research Design, Basic Principles of Experimental Designs, Developing a Research Plan.

Unit-III Sampling, Scaling and Data Analysis: (9 Contact Periods)
Sampling Design, Measurement and Scaling Techniques, Methods of Data Collection, Processing and Analysis of Data, Testing of Hypotheses.

Unit-IV Publication, Copyrights and Plagiarism: (9 Contact Periods)
Review of published research work. Preparing a manuscript for publication, Copyright issues and Plagiarism, Protocol content for research project, Grant writing, Seminar and Scientific presentation.

Recommended Books:-

1. Research Methodology: Methods and Techniques, Kothari CR, New Age International Publishers, New Delhi, 2004.
2. An Introduction to Medical Statistics, 3rd Edition, Bland M, Oxford University Press, 2006.
3. Research Methods for Engineers, David V Theil, Cambridge University Press, 2014.
4. Research Methodology a step-by-step guide for beginners, Ranjit Kumar, SAGE Publications Ltd. London, 2011.

Course Outcomes:-

After successful completion of this course, students shall be able to:

1. Understand some basic concepts of research and its methodologies.
2. Identify and define appropriate research topics, select parameters and design research strategies.
3. Prepare a project proposal (to undertake a project) and write a research report /thesis.
4. Organize and conduct research (advanced project) in a more appropriate manner

VIIth Semester

BTE4177			**Recent Advances in Biotechnology**				**Pre Requisites**		**Principles of Modern Biology BTP1012**	
Version R-01							Co-requisites		Nil	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hrs	3 Hours	10	20	20	50	100

Course Contents:-

Unit-I Review of Literature on Recent Advances in Biotechnology: (9 Contact Periods)
Overview of literature on recent advances in Biotechnology in the areas of microbes, plants, animals including Humans; Latest developments in: detection of human diseases; Stem cell research

Unit-II Case Studies of GMOs: (9 Contact Periods)
Genetic Modification in plants, microbes, animals; Role of microbes in Industry

Unit-III Biotechnology & Environment: (9 Contact Periods)
Carbon credits in clean environment development; Developments in Food Science and Technology

Unit-IV Role of Biotechnology in Forensic and Clinical Research: (9 Contact Periods)
Forensic sciences, Biological Warfare, DNA Vaccines, Future medicines

Recommended Books:-

1. Recent Advances in Plant Biotechnology & its Application, Kumar A & Sopory SK, IK International Publishing House, 2008.
2. Recent Advances in Environmental Biotechnology, Jain PK, Gupta VK & Bajpai V, Lambert Academic Publishing Co., 2011.
3. Recent Advances in Biotechnology, (Nato Science Series E), Vardar FV, Khan S & Sukan SS, Springer, 2012.
4. Advances in Biotechnology, Saxena MK, Madhu Publication, 2016.
5. Recent Advances in Biotechnology, Oloke J, Science Publishing Group, 2016.

Course Outcomes:-

After successful completion of this course, students will be able to:

1. Discuss the latest trends in Biotechnological research.
2. Understand the methods of genetic modification of organisms.
3. Identify the environmental pollutants and methods for pollution control.
4. Describe processes for detection of human diseases based on biotechnological tools.