KERALA TECHNOLOGICAL UNIVERSITY

(THRISSUR CLUSTER - 07)

SCHEME AND SYLLABI

of

M. TECH.

in

INDUSTRIAL BIOTECHNOLOGY

(As on 03/09/2015)

OFFERING DEPARTMENT

BIOTECHNOLOGY ENGINEERING

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

1.	Dr Devdas Menon, Professor, IIT Madras,Chennai	Chairman
2	Principal, Government Engineering College Trichur, Thrissur	Convener
3	Principal, AXIS College of Engineering & Technology, East Kodaly, Murikkingal, Thrissur	Member
4	Principal, IES College of Engineering, Chittilappilly,Thrissur	Member
5	Principal, MET'S School of Engineering, Mala, Thrissur	Member
6	Principal, Royal College of Engineering & Technology, Akkikkavu, Thrissur	Member
7	Principal, Vidya Academy of Science & Technology, Thalakkottukara, Thrissur	Member
8	Principal, Thejus Engineering College, Vellarakkad, Erumappetty, Thrissur	Member
9	Principal, Universal Engineering College, Vallivattom, Konathakunnu ,Thrissur	Member
10	Principal, Sahrdaya College of Engineering & Technology, Kodakara, Thrissur	Member

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulation and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC on 25.6.2015 have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The document has been verified by all the constituent colleges.

Coordinator in charge of syllabus revision of the Programme

Dr Ambili Mechoor
Professor
Department of Biotechnology Engineering
Sahrdaya College of Engineering and Technology
Kodakara,Thrissur.

Principal of the lead college

Dr Sudha George Valavi
Principal
Sahrdaya College of Engineering and Technology
Kodakara,Thrissur

Principals of the colleges in which the programme is offered

No	Name of the College	Principal's Name	Signature
1	Sahrdaya College of Engineering and Technology	Dr Sudha George Valavi	

Date: Chairman
Place:

VISION

- To be a centre of excellence in the field of Biotechnology.
- To focus on teaching and research in diversified fields of Biotechnology.

MISSION

- To mould competent Biotechnologists.
- To become professionally fit, to transform the acquired knowledge gained in Life Sciences and Engineering by apt skills.
- To cope up with the challenges in the field of Biotechnology.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

i. To groom out globally efficient and ethically responsible Engineers to face challenges in a fast moving society

ii. Equip the candidates to work collaboratively, creatively, and communicate effectively in applying discipline-specific knowledge in basic sciences, chemical engineering and biotechnology.

iii. Trouble shoot and analyze issue in the biotech industry and research arena with a commitment to uncompromised product performance and a desire to obtain the best possible environmental impact.

iv. Commitment towards continuous innovation in improving the products and processes.

PROGRAM OUTCOMES (POs)

i. Expertise knowledge in the application various biotechnological and biochemical concepts in an industrial perspective.

ii. Demonstrate and application of knowledge for innovative and modern engineering applications.

iii. Acquire professional and effective communication skills.

iv. Potential to apply mathematical concepts to resolve critical and practical oriented real time industrial challenges.

v. Pursue research to enhance the existing pool of knowledge.

vi. Evolve professional and ethical attitudes to accepted socially responsible citizens.

vii. Understand and corroborate the global biotech industry business and management.

viii. Demonstrate and perceive their role as engineers or entrepreneurs to the overall development of the society.

ix. Design and analyze biological reactors for production of industrially important products (bio molecules).

x. Develop Technological innovations for achieving cleaner production and sustainableindustrial growth.

xi. Design of innovative processes and products whose performance cannot be achievedusing conventional methods

xii. Address the demand for sustainable supply of fuels and food through biological means.

KERALA TECHNICAL UNIVERSITY

M.Tech DEGREE COURSE

IN

INDUSTRIAL BIOTECHNOLOGY

(DEPARTMENT OF BIOTECHNOLOGY ENGINEERING)

Proposed Curricula, Scheme of Examinations & Syllabi

(With effect from 2015 admissions)

(PROPOSED)

SCHEME OF EXAMINATIONS

Semester 1

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	**07MA6007**	Applied Mathematics For Biotechnology	4-0-0	40	60	3	4
B	**07BT6203**	Molecular Biology &Immuno-technology	4-0-0	40	60	3	4
C	**07BT6205**	Fermentation & Enzyme Engineering	4-0-0	40	60	3	4
D	**07BT6207**	Advanced Bioinformatics	3-0-0	40	60	3	3
E	**07BT6209X**	Elective I	3-0-0	40	60	3	3
	07GN6001	Research Methodology	0-2-0	100	0	0	2
	07BT6213	Immunology & Molecular Biology Lab	0-0-2	100	0	0	1
	07BT6215	Introduction to Seminar	0-0-1	-	-	-	-
							Total Credits :21

Semester :2

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	**07BT6202**	Animal and Plant cell Culture	4-0-0	4	60	3	4
B	**07BT6204**	Analytical Techniques in Biotechnology	3-0-0	40	60	3	3
C	**07BT6206**	Transport phenomena in Bioprocess system	3-0-0	40	60	3	3
D	**07BT6208X**	Elective II	3-0-0	40	60	3	3
E	**07BT6210X**	Elective III	3-0-0	40	60	3	3
	07BT6212	Seminar	0-0-2	100	0	0	2
	07BT6214	Mini Project	0-0-4	100	0	0	2
	07IB6216	Bioprocess and Fermentation Technology Lab	0-0-2	100	0	0	1
							Total Credits : 21

Semester : 3

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	**07BT7201X**	Elective IV	3-0-0	40	60	3	3
B	**07BT7203X**	Elective V	3-0-0	40	60	3	3
	07BT7205	Seminar	0-0-2	100	0	0	2
	07BT7207	Project (Phase 1)	0-0-12	50	0	0	6
							Total Credits :14

Semester : 4

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits	
					Marks	Duration (hrs)		
	07BT7202	Project (Phase 2)	0-0-21	100	0	0	12	12
							Total credits: 12	

L-Lecture,T –Tutorial, P-Practical; **TOTAL CREDITS: 68**

LIST OF ELECTIVE COURSES OFFERED

Semester I

ELECTIVE: I

07BT62091- Clinical Biotechnology
07BT62093- Biopharmaceutical& Pharmaceutical Technology
07BT62095- Biopolymer Technology
07BT62097-Protein Engineering

Semester II

ELECTIVE: II

07BT62082- Bioprocess Models: Design and Stability
07BT62084-Food Processing Technology
07BT62086-Metabolic Engineering
07BT62088-Bioprocess Modeling& Simulation

ELECTIVE: III

07BT62102- Molecular Diagnostics
07BT62104-Bioreactor Design
07BT62106-Genomics& Proteomics
07BT62108-Bio-fuel Engineering

Semester III

ELECTIVE: IV

07BT72011-Advanced Bio separation Techniques
07BT72013-Intellectual Property Rights (IPR) for a Global Bio-economy
07BT72015-Molecular Modeling & Drug Discovery
07BT72017-Fundamentals of Synthetic Biology

ELECTIVE: V

07BT72031-Tissue Engineering & Biomaterials
07BT72033-Nanobiotechnology
07BT72035-Management, Entrepreneurship & Bio-business
07BT72037-Structural Biology

FIRST SEMESTER

Course No: 07MA6007
Course Title:APPLIED MATHEMATICS FOR BIOTECHNOLOGY
Credits: 4-0-0:4
Year :2015
Pre-requisites: Nil
Course Objectives:

- *To facilitate the student with necessary helping tools and to understand the design aspects and the kinetic parameters.*

Course Content/ Syllabus :

Finding a basic feasible solution, testing for optimality for transportation problems.Newton's forward and backward interpolation formula.Probability& Statistics, Baye'stheorem.Sampling distributions. Testing of Null hypothesis and testing errors. Curve fitting, Correlation and Regression. Design of experiments : Principles of experimentations. Cluster analysis and trees, ANOVA.

Course Outcome:

- *The student will be able to have basic knowledge in fields of transportation, interpolation, probability, statistics, curve fitting and design of experiments.*
- *The student will also be able to apply in biological sciences.*

Text Books:

1. Introduction to Numerical Analysis (Second Edition), By Hildebrand F.B., Dover Publications, 1987.
2. Richard A Johnson, CB Gupta, Miller and Freund's,' Probability and statistics for engineers', 7th edition, Pearson education.

References

1. Higher Engineering Mathematics 37th edition. By Grewal.
2. Numerical methods, By Kandasamy P., Thilagavathy K., Gunavathy K., S. Chand & Co.,2003.
3. Optimization methods in Operations research and Systems analysis, By Mital K.V. and Mohan C., New Age Publications, 1996.
4. Fundamentals of Operations research, By Ackoff and Sasieni, M.W., Wiley, 1968.
5. Operations Research, By Verma A.P., Kataria and sons, 2001.
6. Comprehensive Statistical methods By P. N arora, SumeetArora, S. Arora. S Chand & Co.
7. Advanced Engineering Mathematics, By E. Kreyszig 8th Edition.
8. Mathematical Statistics, By V C Kapoor& Gupta

COURSE PLAN

COURSE NO: 07MA6007 **COURSE TITLE: APPLIED MATHEMATICS FOR BIOTECHNOLOGY** **(L-T-P : 4-0-0) CREDITS:4**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Transportation: Introduction, transportation problems, finding a basic feasible solution, testing for optimality, Assignment problems.	9	15
MODULE: 2 Interpolation: Introduction, Newton's forward interpolation formula for equal intervals, Newton's backward interpolation formula, error in polynomial	9	15
FIRST INTERNAL TEST		
MODULE: 3 Probability & Statistics: Probability –n Addition theorem, Multiplication theorem and conditional probability – Baye's theorem.	10	15
MODULE: 4 Sampling distributions – Large samples and Small samples. Testing of Null hypothesis- Z test, *t* Test, student *t* test, paired *t* test, and $\chi 2$ test. Type I and Type II errors. Fishers F test. Goodness of fit. Taguchi's statistical methods.	8	15
SECOND INTERNAL TEST		
MODULE: 5 Curve fitting: Curve fitting – fitting a straight line and second degree curve. Correlation and Regression; R^2. Fitting a non linear curve. Bivariate correlation application to biological sciences.	10	20
MODULE:6 Design of experiments: Principles of experimentations. One way – Two way classifications- Randomized Block designs – Latin Square Designs, Factorial experiment. Multivariate analysis, cluster analysis and trees, ANOVA	10	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT6203
Course Title: MOLECULAR BIOLOGY AND IMMUNOTECHNOLOGY
Credits: 4-0-0:4
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Aims for preparing the students for a career in applied research in molecular biology & immunology in therapeutic and technological innovations*

Course Content/ Syllabus:

Organization of Nucleic Acids & Gene Expression.Replication in Prokaryotes and Eukaryotes. Transcription, translation, posts translational Modifications. Recombinant DNA Technology &Applications.Enzymes in Genetic Engineering.The hybridization reaction.Construction of Genomic and cDNA libraries and screening.Biology of complement systems.Purification of mononuclear cells from peripheral blood.Regulation of gene expression.Vaccines.Immune diagnosis of Infectious diseases - immuno screening of recombinant library.

Course Outcome:

1. *To understand the fundamental principles behind nucleic acids organization and gene expression.*
2. *To gain in depth knowledge in rDNA technology, immunotechnology and its applications.*

Text Books:

1. David Friefelder, *Molecular Biology (2e)*, Jones and Bartlett Publishers Inc, 1987.

2. Primrose S.B and R. W. Old, *Principles of gene manipulation - An introduction to genetic engineering (Vol. 2)*, Blackwell Scientific Publications, 1980.
3. Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.
4. Immunology, L.M. Roitt, J. Brestoff and D.K. Male, 1996.

References:

1. Walker J.M and R.Rapley, *Molecular Biology and Biotechnology*, Indian Reprint byPanima Publishing Corporation, 2000.
2. Sambrook J et al, *Molecular Cloning (Vol I, II and III)*, Cold Spring Harbor Laboratory(CSHL) Press, 1989
3. Immuno-biology, Janeway CA and Paul Travers 1994.
4. Immunological Techniques, D.M. Weir, 1992

COURSE PLAN

COURSE NO: 07BT6203 **COURSE TITLE: MOLECULAR BIOLOGY AND IMMUNOTECHNOLOGY** **(L-T-P : 4-0-0) CREDITS:4**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Organization of Nucleic Acids & Gene Expression:Structure and Different forms of DNA and RNA, Organization of DNA in Prokaryotic and Eukaryotic Chromosomes. DNA Replication in Prokaryotes and Eukaryotes, Telomeric Replication in Eukaryotes. Transcription, translation, posts translational Modifications.	8	15
MODULE: 2 Recombinant DNA Technology & Applications: Introduction to cloning, Method of creating recombinant DNA molecules, Cloning Vectors, Expression Vectors. Enzymes in Genetic Engineering. The hybridization reaction, Production and Labeling of Gene Probes, Southern Blotting, Northern Blotting, in situ hybridization.	10	15
FIRST INTERNAL TEST		
MODULE: 3 Construction of Genomic and cDNA libraries and screening. Applications of Recombinant DNA Technology as Diagnostic Tools- SNPs, VNTRs, Drugs and Therapies- Therapeutic proteins from Transgenic plants and animals, Gene Therapy Combating Disease. DNA fingerprinting, Directed mutagenesis, Antisense Technology.	9	15
MODULE: 4 Biology of complement systems - structure and function of MHC class I and II molecules - antigen recognition and presentation - humoral and Cell mediated immune responses - hypersensitivity reaction - immune suppression and immune tolerance - auto immune	9	15

disorders. antigen - antibody reaction in immunodiagnostic; hybridoma and monoclonal antibody production; - human monoclonal antibodies; catalytic antibodies - complement fixation.		
SECOND INTERNAL TEST		
MODULE: 5 Purification of mononuclear cells from peripheral blood .fluorescent activated cell sorter - mitogen and antigen induced lympho-proliferation assay - cell mediated lympholysis - mixed lymphocyte reaction. - macrophage cultures and macrophage activation .	10	20
MODULE : 6 Regulation of gene expression- The Operon Concept – Promoter, Operator, Terminator, Attenuator, Inducer, Repressor, Effect of cAMP Complex; lac operon.DNA Repair, Mutagenesis and Mutations. generation of T cell clones - HLA typing. Biology and assay of cytokines. Vaccines. Immune diagnosis of Infectious diseases - immuno screening of recombinant library.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT6205

Course Title:FERMENTATION AND ENZYME ENGINEERING

Credits: 4-0-0:4

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Aims at transformation and industrialization of industrial enzyme,*
- *New technical innovation of fermentation engineering,*
- *High expression and mass preparation of proteins.*

Course Content/ Syllabus:

Fermentation &processing.Medium requirements for fermentation processKinetics of substrate utilization, product formation and biomass production.Simple unstructured kinetic

Models for microbial growthStructured kinetic Models. The production of some commercially important Organic acids, amino acids and alcohols, study of production processes for various classes of low molecular weight secondary metabolites. Principles of enzyme catalysis.Industrial utilization of enzymes.

Course Outcome:

1. *To familiarise the fermentation and processing techniques*
2. *To understand the kinetics of substrate utilization, product formation and biomass production*

Text Books:

1. Cruger.W and A.Cruger, *A Textbook of Industrial Microbiology* (*2e),* Sinauer Associates, Sunderland,US, 2004.
2. Michael Shuler and FikretKargi, *Bioprocess Engineering: Basic Concepts (2e),* Prentice Hall, Englewood Cliffs, NJ, 2002.

References:

1. Stryer.L, *Biochemistry (4e),* Freeman, 2002.
2. Bailey .J.E and D. F. Ollis, *Biochemical Engineering Fundamentals (2e),* Mc-Graw Hill, Inc., 1986.
3. Pauline M Doran, *Bioprocess engineering principles (1e),* Academic Press, 1995.
4. Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox. 1993. Worth Publishers, New York

COURSE PLAN

COURSE NO: 07BT6205 **COURSE TITLE: FERMENTATION AND ENZYME ENGINEERING** **(L-T-P : 4-0-0) CREDITS:4**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Fermentation& processing: Introduction to fermentation technology: Upstream and downstream processing of biomolecules. Isolation, Preservation and Improvement of Industrial Micro-Organisms; Medium requirements for fermentation process; Criteria for good medium; Sterilization - batch and continuous heat sterilization of liquid media, filter sterilization of liquid media and Air. Design of sterilization equipment.	10	15
MODULE: 2 Kinetics of substrate utilization, product formation and biomass production: Phases of cell growth in batch cultures -		

transient growth kinetics, Simple unstructured kinetic Models for microbial growth, Growth of filamentous organisms; Environmental conditions affecting growth kinetics, substrate and product inhibition on cell growth and product formation	8	15
FIRST INTERNAL TEST		
MODULE: 3 Structured kinetic Models, segregated kinetic Models of growth. Production of primary and secondary metabolites. The production of some commercially important Organic acids, amino acids and alcohols, study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics, quinones, aromatics, Vitamins and Steroid.	8	15
MODULE : 4 Principles of enzyme catalysis: Proteins as enzymes; Classification of Enzymes; Mechanism of Enzyme Action; Determination of elementary step rate kinetics, patterns of substrate concentration dependence, Modulation and regulation of enzyme activity .	10	15
SECOND INTERNAL TEST		
MODULE: 5 Industrialapplication of enzymes:Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulose, artificial enzymes, Enzyme Modification - site directed mutagenesis; immobilized enzyme in industrial processes.	9	20
MODULE: 6 Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin. Industrial utilization of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.	9	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT6207

Course Title:ADVANCED BIOINFORMATICS

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Basic Knowledge in Bioinformatics

Course Objectives:

- *Provide critical tools for managing the immense volume of biological data and increase the efficiency of drug discovery and development.*

Course Content/ Syllabus:

Scope of Bioinformatics, Applications in various fields. Databases, Hidden Markov Models. Applications.Information retrieval from biological databases.Programming skills in Bioinformatics and PERL.Comparative genomics. Phylogenetic analysis, Sequence annotation: principles of genome annotation- annotation tools & resources. Virtual screening and compound ranking/scoring.Receptor-ligand interactions analysis. Scaffold hopping, 3D database screening. Explicit/implicit solvation Models

Course Outcome:

1.To familiarise with the algorithms working behind Bioinformatics software.

2. To improve the programming skills in Perl programming..

Text Books:

1. Bioinformatics, David.W.Mount
2. Essential Bioinformatics, Jin Xion

References:

1. Bioinformatics, Andreas D. Baxevanis
2. Perl for Bioinformatics, James Tisdall

COURSE PLAN

COURSE NO: 07BT6207 COURSE TITLE: ADVANCED BIOINFORMATICS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Scope of Bioinformatics, Applications in various fields, Types of Databases, Hidden Markov Models. Applications: Modeling Protein sequence families, multiple alignments.	5	15
MODULE: 2 Nucleotide databases, Protein databases, specialized databases, Disease databases, information retrieval from biological databases.	5	15
FIRST INTERNAL TEST		
MODULE: 3 Programming skills in Bioinformatics, PERL: Introduction and basics of PERL, variables, numbers, operators, loops, Arrays, Hashes, Control structures, File handling, strings manipulations, regular expressions.	10	15
MODULE: 4 Comparative genomics, Motif representation: consensus, regular expressions; PSSMs; phylogenetic analysis-steps in phylogenetic analysis, Sequence annotation: principles of genome annotation- annotation tools & resources.	10	15
SECOND INTERNAL TEST		
MODULE: 5 Virtual screening and compound ranking/scoring. Receptor-ligand interactions analysis, Fragment-based design, *de novo* design (LUDI), Pharmacophore generation (Catalyst)	6	20
MODULE: 6 Scaffold hopping, 3D database screening. Explicit/implicit solvation Models, Protein Modeling (MODELER®) and analysis. Protein-protein docking and refinement.	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100

Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07GN6001`

Course Title:RESEARCH METHODOLOGY

Credits: 0-2-0:2

Year: 2015

Pre-requisites: Nil

Course Objectives:

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

- *The scientific research process and the various steps involved*
- *Formulation of research problem and research design*
- *Thesis preparation and presentation.*
- *Research proposals, publications and ethics*
- *Important research methods in engineering*

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self study and group discussions. The faculty mainly performs a facilitator's role.

Course Content/ Syllabus:

Overview of research methodology - Research process, scientific method, research design process.

Research Problem and Design - Formulation of research task, literature review, web as a source, problem solving approaches, experimental research, and ex post facto research.

Thesis writing, reporting and presentation -Interpretation and report writing, principles of thesis writing- format of reporting, oral presentation.

Research proposals, publications and ethics - Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights.

Research methods – Modelling and Simulation, mathematical modeling, graphs, heuristic optimization, simulation modeling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

Course Outcome:

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

- *Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.*
- *Analyze and evaluate research works and to formulate a research problem to pursue research*
- *Prepare a thesis or a technical paper, and present or publish them*
- *Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.*
- **Text Books:**
    1. David Friefelder, *Molecular Biology (2e),* Jones and Bartlett Publishers Inc, 1987.
    2. Primrose S.B and R. W. Old, *Principles of gene manipulation - An introduction to genetic engineering (Vol. 2),* Blackwell Scientific Publications, 1980.
    3. Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.
    4. Immunology, L.M. Roitt, J. Brestoff and D.K. Male, 1996.

References:

1. Walker J.M and R.Rapley, *Molecular Biology and Biotechnology,* Indian Reprint byPanima Publishing Corporation, 2000.

2Sambrook J et al, *Molecular Cloning (Vol I, II and III),* Cold Spring Harbor Laboratory(CSHL) Press, 1989

3.Immuno-biology, Janeway CA and Paul Travers 1994.

4Immunological techniques, D.M. Weir, 1992

COURSE PLAN

COURSE NO: 07GN6001 **COURSE TITLE: RESEARCH METHODOLOGY** **(L-T-P : 0-2-0) CREDITS:2**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1- Overview of Research Methodology Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional research	5	10
MODULE 2- Research Problem and Design	5	10

Formulation of research task – literature review – methods – primary and secondary sources – web as a source –browsing tools -formulation of research problems – exploration - hypothesis generation - problem solving approaches-introduction to TRIZ(TIPS)-experimental research – principles -Laboratory experiment - experimental designs - ex post facto research - qualitative research		
FIRST INTERNAL TEST		
MODULE 3- Thesis writing, reporting and presentation Interpretation and report writing – techniques of interpretation – precautions in interpretation – significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions. oral presentation – preparation - making presentation – use of visual aids - effective communication	4	15
MODULE 4 -Research proposals, publications, ethics and IPR Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing –scientometry-impact factor- other indexing like h-index – citations - open access publication -ethical issues - plagiarism –software for plagiarism checking- intellectual property right- patenting case studies	5	15
SECOND INTERNAL TEST		
MODULE 5- Research methods – Modelling and Simulation Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs heuristics and heuristic optimization - simulation modelling	5	10
MODULE 6 – Research Methods – Measurement, sampling and Data acquisition Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	4	10
THIRD INTERNAL TEST		

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests and assignments. There arethree tests for the course (3 x 20 = 60 marks) and assignments (40 marks). The assignments can be in the form of seminar, group tasks, case studies, research work or in a suitable format as decided by the teacher. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Course No: 07BT6213

Course Title:IMMUNOLOGY AND MOLECULAR BIOLOGY LAB

Credits: 0-0-2:2

Year :2015

Pre-requisites: Nil

Objectives:

- *To provide hands on training towards the application of molecular techniques and products of industrial importance*

Course Content/ Syllabus

1. Isolation ,estimation and electrophoresis of DNA from organisms
2. Isolation of plasmid and quantification
3. Isolation of RNA and quantification
4. Restriction digestion
5. Purification of DNA from gel and Ligation
6. Competent cell preparation and Transformation
7. Conjugation in E.coli:Phage infection in E.coli
8. Induction of Lac operon.
9. Protein Isolation and estimation from microbes
10. Separation of lymphocytes from blood and staining of blood cells
11. Antigen antibody interaction-Haemagglutination, Immunodiffusion, Immunoelectrophorosis
12. Immunoprecipitation
13. Enzyme linked Immunosorbant Assay(ELISA)
14. Isolation of Immunoglobulins and quantification
15. Western blotting

References:

1. Practical immunology-Frank C HayandOlwyn M R Westwood Blackwell science
2. Manual of immunological methods- Pauline Brousseau.

Internal Continuous Assessment *(Maximum Marks-100)*

i) Practical Records /outputs – 40 Marks
ii) Regular Class Viva-Voce- 20 Marks
iii) Final Test (Objective)– 40 Marks

Course No: 07BT6215

Course Title:INTRODUCTION TO SEMINAR

Credits: 0-0-1: 0

Year: 2015

Pre- requisites: Nil

Course Objectives:

- To improve the debating capability of the student to present a technical topic
- To impart training to the student to face audience and present his/her ideas and thus instill self esteem and confidence essential for an engineer.

Outline:

Individual students are required to choose a topic of their interest and give a seminar on that topic forabout 30 minutes. A committee consisting of at least three faculty members shall assess the presentationof the seminar. The committee will provide feedback to the students about the scope for improvements incommunication, presentation skills and body language. Each student shall submit one copy of the reportof the seminar topic.

Course Outcomes:

- The graduate will have improved the debating capability and presentation skills in anytopic of his/her choice.

SECOND SEMESTER

Course No: 07BT6202
Course Title : ANIMAL& PLANT CELL CULTURE

Credits: 4-0-0:4

Year: 2015
Pre-requisites: Nil
Course Objectives:

- *An introduction to plant and animal cell tissue culture techniques, nucleic acid transfections and industrial applications of cell culture.*

Course Content/ Syllabus:
Plant tissue culture techniques, preparation of tissue culture media, gene transfer method in plants, plant regeneration from embryo, meristem and callus culture. Androgenesis: Anther and pollen culture history of animal cell culture development, Different type of cell culture media, cell lines, characterization and maintenance of cell lines Animal tissue and Organ culture- Products and their Applications.

Course Outcome:

1.Describe how cell culture can be used for in vitro studies and commercial applications.

2.Identify the problems associated with growing, storing and identifying a wide range of different cell types.

Text Books:

1. Dodds J **.**H. PlantGenetic Engineering, Cambridge University Press.
2. Freshney RI. 2005. *Culture of Animal Cells*. Wiley Liss.
3. Portner R. 2007. *Animal Cell Biotechnology*. Humana Press

References: _

1. Mantal S.H., Mathews J.A.Mickee R.A. *Principles of Plant Biotechnology An Introduction to Genetic Engineering in plants,* Blackwell Scientific Publications
2. Bernur R. Pastrnek. J.J. , Molecular Biology, Principles and Applications in recombinant DNA, Panima Publishing Cooperation, New Delhi

COURSE PLAN

COURSE NO: 07BT6202 **COURSE TITLE: ANIMAL & PLANT CELL CULTURE** **(L-T-P : 4-0-0) CREDITS:4**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Fundamentals of plant tissue culture, plant regeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Cell/callus line selection for resistance to herbicide, stress and diseases. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds"; haploid production: advantages and methods.	10	15
MODULE: 2 Protoplast technology: isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids, applications of protoplast technology. Specific gene transfer: indirect and direct methods, current status and limitations. Automation in plant tissue culture. Field techniques for propagation of regenerated plants	8	15
FIRST INTERNAL TEST		
MODULE : 3 Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; Induction and growth parameters; Chromosomal variability in callus culture. Plant regeneration from embryo, meristem and callus culture. Androgenesis: Anther and pollen culture; Isolation and culture of protoplasts. Vectors in plant biotechnology	8	15
MODULE : 4 Introduction, importance, history of animal cell culture development, different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture, organ culture etc. Different type of cell culture media, growth supplements, serum free media balanced salt solution, other cell culture reagents.	10	15
SECOND INTERNAL TEST		

MODULE: 5 Culture of different tissues and its application. Behavior of cells in culture conditions, division, their growth pattern, metabolism of estimation of cell number, Development of cell lines, characterization and maintenance of cell lines, stem cells, cryopreservation, common cell culture contaminants.	10	20
MODULE: 6 Animal tissue and Organ culture- Plasma clot method, Raft method, Agar-gel method, Grid method, etc. Cyclic exposure to Medium and Gas phase, Advantages, limitations and applications, artificial skin. Products and their Applications, Transgenics and Prospectives, Principles of *invitro* fertilization	10	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT6204

Course Title: ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Integrate the theory and practice for analyzing and quantitating biomolecules obtained from various sources*

Course Content/ Syllabus:

Development and application of Modern analytical instrumentation, Protein separation techniques and its detection methods .Hybrid techniques, Immunoassay, Advanced analytical techniques, Lab on chip

Course Outcome:

1. *Explain the working of modern analytical instruments and use them effectively in their research work.*
2. *Instrumentation in quality assessment of biological and pharmaceuticals*

Text Books:

1. Practical Biochemistry – Wilson and Walker.
2. Handbook of analytical separations, vol. 4, byIanWilson,2003
3. Encyclopedia of spectroscopy and spectrometry, vol. 1-3,2000
4. Methods ofbiochemicalAnalysis,Vol.35,ClarenceSuelter,1991
5. MethodsofbiochemicalAnalysis,Vol.36,ClarenceSuelter,199

References:

1. Understanding NMR Spectroscopy by James Keeler.
2. Basic One- and Two-Dimensional NMR Spectroscopy Paperback – Import, 27 Oct 2010by Horst Friebolin
3. Fundamentals of Microfluidics and Lab on a Chip for Biological Analysis and Discovery By Paul C.H. Li.

COURSE PLAN

COURSE NO: 07BT6204 **COURSE TITLE: ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Development and application of Modern analytical instrumentation. Electrophoresis, Chromatography: HPLC and detection methods	6	15
MODULE: 2UPLC, GC, HPTLC, Ion exchange chromatography, gel filtration chromatography and detection methodologies.	6	15
FIRST INTERNAL TEST		
MODULE : 3 Hybrid techniques: Gas chromatography with Fourier transforms infra red spectroscopic detection(GC-FTIR), gas chromatography with mass spectrometric detection(GC-MS)	8	15

MODULE: 4 Liquid chromatography with mass spectrometric detection(LC-MS and LC-MS/MS),andinductively coupled plasma with mass spectrometric detection(ICP-MS).	10	15
SECOND INTERNAL TEST		
MODULE: 5 Immunoassay: radioimmunoassay (RIA); enzyme-multiplied immunoassay technique (EMIT); fluorescence polarization immunoassay(FPIA); closed enzyme donor immunoassay (CEDIA);enzyme-linked immunosorbent assay (ELISA).	6	20
MODULE : 6 Advanced analytical techniques : Application of IR and NMR spectroscopy, Mass spectrometry , Lab on chip	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT6206
Course Title:TRANSPORT PHENOMENA IN BIOPROCESS SYSTEM
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *To understand the balance between momentum, energy and mass in bioprocess systems*

Course Content/ Syllabus:

Introduction to Transport Phenomena -Fermentation Broth Rheology-flow regimes in a bioreactor- basic concepts of heat transfer and its application in bioconversions-basic concepts of diffusion-role of diffusion in bioprocessing-Oxygen transport to microbial cultures-determination of oxygen mass transfer coefficient by various method.

Course Outcome:

1. *Ability to analyze industrial problems along with appropriate approximations and and boundary conditions.*

Text Books:

1. Pauline M. Doran, *Bioprocess Engineering Principles,* Academic Press, 1995.
2. Blanch H.W and Douglas S. C, *Biochemical Engineering,* CRC Press, 1997.
3. Michael L Shuler and FikretKargi, *Bioprocess Engineering: Basic Concepts,* Prentice-Hall of India Pvt Ltd, 2008.

References:

1. Arthur T. Johnson, *Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems,* John Wiley and Sons, 1998.

COURSE PLAN

COURSE NO: 07BT206 **COURSE TITLE: TRANSPORT PHENOMENA IN BIOPROCESS SYSTEM** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
MODULE : 1 Introduction to Transport Phenomena – momentum, heat and mass transfer in bioprocessing Review of basic concepts – Conservation of Mass, Conservation of Energy, Momentum Balance – Momentum Balance in a Circular Pipe, Flow Velocity Profile	6	15
MODULE : 2 Fermentation Broth Rheology – Viscosity, Rheological Properties of Fermentation Broths, Factors affecting broth viscosity Mixing in a Bioreactor – Flow regimes with and without baffles, various types of impellers and mixing equipment.	8	15
FIRST INTERNAL TEST		
MODULE: 3 Review of basic concepts – Various Modes of heat transfer, viz., conduction convection and radiation. Calculation of Heat-Transfer Coefficients. Application of heat transfer in bioprocessing,	8	15
MODULE : 4 Heat Management in Bioreactors, Relationship between heat transfer, cell concentration and stirring conditions	8	15

Review of basic concepts – Diffusivity, theory of diffusion, analogy between mass, heat and momentum transfer, role of diffusion in bioprocessing.		
SECOND INTERNAL TEST		
MODULE: 5 Definition of binary mass transfer coefficients. Convective mass transfer – Liquid-solid mass transfer, liquid-liquid mass transfer, gas liquid mass transfer. Oxygen transport to microbial cultures – Gas liquid mass transfer fundamentals.	6	20
MODULE: 6 Oxygen requirement of microbial cultures. Oxygen transfer by aeration and agitation. Determination of oxygen mass transfer coefficient by various methods including dynamic gassing out and oxygen balance methods.	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No:07BT6212
Course Title: SEMINAR

Credits: 0-0-2:2

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *To assess the debating capability of the student to present a technical topic.Also to impart training to a student to face audience and present his ideas and thus creating in him / herself esteem and courage that are essential for an engineer.*

Outline

- All students are required to choose a topic of their interest from Industrial Biotechnology and its applications related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar and

award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

- **Internal continuous assessment: 100 marks**

  Marks for the report: 30%

  Presentation: 40%

  Viva Voce: 30%

Course No: 07BT6214

Course Title: MINI PROJECT

Credits: 0-0-4: 2

Year: 2015

Pre-requisites: Nil

Course Objectives:

- To estimate the ability of the student in transforming the theoretical knowledge studied so far into an application at the basic research level that could lead to an industrial application. For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year. The basic concepts of product design may be taken into consideration while designing the project. A committee consisting of minimum three faculty members specialised in biotechnology/chemical engineering/instrumentation engineering will perform assessment of the mini project. Students have to submit a report on the mini project and demonstrate the mini project before the evaluation committee.

- **Internal continuous assessment: 100 marks**

  Marks for the report: 20%

  Demonstration and Presentation: 50%

  Results: 30%

Course No: 07BT6216

Course Title: BIOPROCESS & FERMENTATION TECHNOLOGY LAB

Credits: 0-0-2:2

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *To understand and apply the basic and advanced concepts of fermentation and bioprocess in industry*

Course Content/ Syllabus:

1. Isolation of industrially important microbes (Bacteria, Actinomycetes&Fungi) from environment
2. Identification and Culture preservation of industrially important microbes
   a. Staining techniques (Gram staining &Fungal staining)
   b. Glycerol stock preparation
3. Production of extracellular enzyme by liquid fermentation and Quantification of enzyme activity and specific activity
4. Kinetics study of enzymes
5. Techniques of enzyme immobilization
6. Production of metabolites by solid state fermentation
7. Strain improvement by non recombinant methods-Physical mutation and chemical mutation
8. Experimental design for improvement of fermentation by Plackett-Burman method
9. Study of Rheology of fermentation broth
10. Determination of volumetric mass transfer coefficient by sodium sulphite oxidation method.
11. Down stream processing :a. Cell rupture ,b. Precipitation,c. Dialysis,d. Chromatography
    e. Molecular weight determination by SDS PAG

References:

1. Practical Fermentation Technology- Brian McNeil, Linda M.Harvey- John Wiley & Sons, Ltd
2. Enzyme Technology Martin F. Chaplin , Christopher Bucke

Internal Continuous Assessment *(Maximum Marks-100)*

i) Practical Records /outputs - 40%

ii) Regular Class Viva-Voce- 20%

iii) Final Test (Objective) -40%

THIRD SEMESTER

Course No:07BT7205
Course Title:SEMINAR

Credits: 0-0-2:2

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *To assess the debating capability of the student to present a technical topic.Also to impart training to a student to face audience and present his ideas and thus creating in him / herself esteem and courage that are essential for an engineer.*

- All students are required to choose a topic of their interest from Biotech Business and entrepreneurship development related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

- **Internal continuous assessment: 100 marks**

  Marks for the report: 30%

  Presentation: 40%

  Viva Voce: 30%

Course No:07BT7207

Course Title:PROJECT [PHASE 1]

Credits: 0-0-12: 6

Year: 2015

Course Objective:

- *To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.*

Outline

The project work can be a purely research based / industry based project which contains and applies the basic and advanced principles of biotechnology as well as chemical engineering. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If it is found essential, they may be permitted to continue their project outside the parent institute subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the Masters research project phase-I during the third semester and the same is continued in the 4^{th} semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4^{th} semester.

- **Internal continuous assessment :Marks 50**

Progress evaluation by the Project Supervisor: 20 Marks

Presentation and evaluation by the Committee: 30 Marks

FOURTH SEMESTER

Course No:07BT7202
Course Title:PROJECT [PHASE 2]
Credits: 0-0-12:12
Year: 2015

Course Objective:

- *To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.*

Outline

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

- **Internal Continuous Assessment: 100 marks**

Project evaluation by the Supervisor/s : 30 Marks
Presentation & evaluation by the Committee : 40 Marks
Evaluation by the External expert : 30 Marks

ELECTIVES

ELECTIVE I

07BT6209X

Course No: 07BT62091
Course Title:CLINICAL BIOTECHNOLOGY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *To understand the design of Clinical trails and research*
- *To know about some of the important biological , their use and applications in the pharmasector*

Course Content/ Syllabus:
Clinical study and design of clinical studies.Epidemiological research and treatment studies. Observational studies: Cohort study- Prospective cohort and Retrospective cohort. Community survey and Ecological study. Seasonal studies. Statistical Analysis and Interpretation:Drug Design and Synthesis. Statistical Application Software.Study of Therapeutic Proteins and Related Case Studies.Cancer Biology and Therapy Clinical Toxicology.Clinical Research Governance and Ethics.

Course Outcome:

1. *Design and carry out clinical studies*
2. *Statistical analysis and Interpretation of clinical data*

Text Books:

1. Pharmaceutical Biotechnology, Second Edition by Michael J. Groves
2. Medical Biotechnology by JuditPongracz, Mary Keen (2009)
3. Medical Biotechnology by FirdosAlam Khan (2012)

References:

1. Leon Lachmanetal, *Theory and practice of Industrial Pharmacy,* Lea arid Febiger.
2. Richard B. Silverman, *The Organic Chemistry of Drug Design and Drug Action, Elsevier, Publications.*
3. Rang Dale Riter, Pharmacology, Churchill Livingstone

COURSE PLAN

COURSE NO: 07BT62091 COURSE TITLE: CLINICAL BIOTECHNOLOGY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Introduction to Clinical study and design of clinical studies. Epidemiological research and treatment studies: Double-blind and Single-blind Randomized controlled trial, Non-blind trial, Nonrandomized trial-quasi-experiment.	5	15
MODULE: 2 Observational studies: Cohort study- Prospective cohort and Retrospective cohort. Time series study, Case-control study and Nested case-control study. Community survey and Ecological study. Seasonal studies: Conduction of studies in seasonal indications such as Allergies and Influenza.	5	15
FIRST INTERNAL TEST		
MODULE: 3 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.	8	15
MODULE: 4 DrugDesign 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).	6	15
SECOND INTERNAL TEST		
MODULE: 5 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. Blood bags, storage of blood	10	20
MODULE: 6 Clinical **Research Governance and Ethics:** Overview on regulatory affairs for pharmaceuticals, neutraceuticals and medical devices. Good Clinical Practices (GCP). 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.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62093

Course Title:BIOPHARMACEUTICAL& PHARMACEUTICAL TECHNOLOGY

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Prepare individuals for employment in pharmaceutical manufacturing and related industries*

Course Content/ Syllabus:

Pharmaceuticals, biologics and biopharmaceuticals.Pharmacokinetics.ADME.Biopharmaceuticals,pharmaceutical biotechnology. Preclinical Pharmacokinetics .CompartmentModeling.Pre-clinical trials, Clinical trials.Patenting- Patent types.Special Concerns for the Preclinical Evaluation of Biotechnology Products.The drug development and manufacturing process.Regulations for Industries.

Course Outcome:

1. *To get acquainted with the basic concepts in pharmaceuticals, biologics and biopharmaceuticals*
2. *To understand the details about pharmacokinetics*
3. *Acquire sufficient knowledge on the functioning of pharma and biopharma industries*

Text Books:

1. Heinrich Klefenz ,*Industrial pharmaceutical biotechnology*, John Wiley sons, 2002.
2. Susanna Wu-Pong, YongyutRojanasakul, and Joseph Robinson, *Biopharmaceutical drug and design and development*, Humana Press, 2007.
3. Gary Walsh, *Biopharmaceuticals: Biochemistry and Biotechnology (2e)*, John Wiley & Sons, 2003.

References:

1.Herbert A Kirst, Wu-KuangYeh; Milton J, *Enzyme Technologies for pharmaceutical andbiotechnological applications*, WILEY-VCH Verlag, 2003.

COURSE PLAN

COURSE NO: 07BT62093 **COURSE TITLE:BIOPHARMACEUTICAL & PHARMACEUTICAL TECHNOLOGY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Introduction to pharmaceutical products, Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future, Basic Issues in the Manufacture of Macromolecules, Traditional pharmaceuticals of biological origin-animal origin, plant origin, microbial origin.	7	15
MODULE: 2 Pharmacokinetics**:** Pharmaco-Kinetics- absorption of drugs, distribution of drugs, protein binding of drugs, Biotransformation of drugs, bioavailability and bioequivalence, excretion of drugs	8	15
FIRST INTERNAL TEST		
MODULE: 3 Pharmacokinetics – effects of food and fasting. Preclinical Pharmacokinetics Compartment Modeling- one compartment open Model, two compartment open Model, multi compartment Model, non linear kinetics.	6	15
MODULE: 4 **The drug development and manufacturing process**: Drug discovery, Pre-clinical trials, Clinical trials. Patenting- Patent types, The patent application, Patenting in biotechnology,.	6	15
SECOND INTERNAL TEST		
MODULE: 5 Special Concerns for the Preclinical Evaluation of Biotechnology Products, Immunotoxicology in biopharmaceutical development, formulation and Delivery of Therapeutic Proteins, Stability Testing, Filling, and Packaging.	7	20

MODULE: 6 Regulations **for Industries**: The role and remit of regulatory authorities-The Food and Drug Administration, The investigational new drug application, The new drug application, European regulations, WHO good manufacturing practices: main principles for pharmaceutical products. Hazard and risk analysis in pharmaceutical products.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62095
Course Title:BIOPOLYMER TECHNOLOGY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Altering the molecular structure of polysaccharides by enzymatic and chemical means*
- *Help in offering solutions towards technology development for biodegradable polymers*

Course Content/ Syllabus:
Biopolymers – The current scenario,Biopolymers and Artificial Biopolymers in Biomedical Applications, an Overview, Novel Synthesis. Preparation and Characterizations, Composite Materials Based on Gelatin and Fillers from Renewable Resources. Biosynthesis and Modifications of xanthum gum, PHA, PHB etc. Bio-surfactants: Source, characteristics and properties. Production of Bio-surfactants.Material Testing and Analytical Methods.Case studies.

Course Outcome:

1. *To understand the basic concepts about biopolymers.*
2. *To familiarise with Biopolymer Technology and Applications*

Text Books:

1. EmoChiellini ,EmoChiellini and Helena Gil**,** *Biorelated Polymers: Sustainable Polymer Science and Technology*, Springer 2001.
2. Johnson .R.M, L.Y. Mwaikambo and N. Tucker, *Biopolymers***,** Rapra Technology, 2003.

References:

1. NaimKosaric*(Ed). Biosurfactants.*Marcell Dekker Inc, 1993.

COURSE PLAN

COURSE NO: 07BT62095 COURSE TITLE:BIOPOLYMER TECHNOLOGY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Introduction: Biopolymers – The current scenario, different biopolymers – produced from various renewable resources, characteristics, merits and demerits over conventional polymers.	6	15
MODULE: 2 Biopolymer Technology and Applications: Biopolymers and Artificial Biopolymers in Biomedical Applications, an Overview, Novel Synthesis of Biopolymers and Their Medical Applications, Composite Films Based on Poly (Vinyl alcohol) and LignocellulosicFibres:	6	15
FIRST INTERNAL TEST		
MODULE: 3 Preparation and Characterizations, Composite Materials Based on Gelatin and Fillers from Renewable Resources: Thermal and Mechanical Properties, Properties of PHAs and Their Correlation to Fermentation Conditions.	8	15
MODULE: 4 Biosynthesis and Modifications: Synthesis and Modification of different Biopolymers like xanthum gum, PHA, PHB etc. Polymers for storing biological molecules (blood bags).	6	15
SECOND INTERNAL TEST		
MODULE : 5 Bio-surfactants**:** Source, characteristics and properties of Bio-surfactants; Production of Bio-surfactants via the fermentation and biotransformation routes; Production of Bio-surfactants with immobilized cells; Integrated bioprocess for continuous production of Bio-surfactants including downstream processing; Applications of Bio-surfactants – Food Industry, Environmental Control.	8	20

MODULE: 6 Material Testing and Analytical Methods: An Overview of Available Testing Methods, Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Structure-Biodegradability Relationship of biopolymers Case studies.Optimization of production and purification of Xanthum gum and other biopolymers like PHA, PHB.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62097
Course Title:PROTEIN ENGINEERING
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Knowledge of structure and function of amino acids , protein structure

Course Objectives:

- *Learn structure and function of proteins of particular importance, the student will know the production of recombinant insulin & in general how to engineer protein to be used as therapeutics*

Course Content/ Syllabus:

The protein makeup. Interaction and elucidation of protein structure with electromagnetic radiation. Peptide mapping, peptide sequencing, significance of Ramachandran'splot.High-throughput protein sequencing setup. Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins.Design and construction of novel proteins and enzymes, Conformation of proteins in general and enzymes in particular.Effect of amino acids on structure of proteins, Energy status of a protein molecule.

Course Outcome:

1. *To have a deeper understanding of thephysico chemical make up of proteins.*
2. *To understand the structure function relationship between proteins*

Text Books:

1. Voet D. and Voet G., "Biochemistry", Third Edn. John Wiley and Sons, 2001
2. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993

References:

1. Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999
2. Moody P.C.E. and Wilkinson A.J. "Protein Engineering", IRL Press, Oxford, UK, 1990.

COURSE PLAN

COURSE NO: 07BT62097 **COURSE TITLE:PROTEIN ENGINEERING** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Protein interactions: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander vals interactions in protein organization. Interaction and elucidation of protein structure with electromagnetic radiation. Peptide mapping, peptide sequencing, significance of Ramachandran's plot.	5	15
MODULE: 2 High-throughput protein sequencing setup Secondary structures: Alpha, beta and loop structures and methods to determine. Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites. Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes.	6	15
FIRST INTERNAL TEST		
MODULE: 3 Structure function relationship: DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers.	5	15
MODULE: 4 Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine	6	15

proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications.		
SECOND INTERNAL TEST		
MODULE: 5 Design and construction of novel proteins and enzymes, Physical methods such as x-ray crystallography for determination of protein structure, Site directed mutagenesis for specific protein function, Basic concepts for design of a new protein/enzyme molecule.	10	20
MODULE : 6 Protein phosphorylation – immunoglobulins - Nucleotide binding proteins – enzyme serine proteases - ribonuclease – lyzozyme ,methods to alter primary structure of proteins –Engineered proteins – de novo protein design. Therapeutics - cellular and molecular therapeutics, Interferons, insulin, monoclonal antibodies in therapy.	10	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

ELECTIVE II

07BT6208X

Course No: 07BT62082
Course Title:BIOPROCESS MODELS: DESIGN AND STABILITY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Knowledge of MATLAB
Course Objectives:

- *Develop knowledge and appreciation of the conceptual and factual bases for bioprocess design and operation*

Course Content/ Syllabus:
Aspects of Modeling in bioprocess industries-Uses and limitations of mathematical Models.Importance of probability and Stochasticity in biological process. Characteristics of a dynamical system:Monad Model, Lotka-Volterra systems. Numerical methods for solving a linear system:Development of mathematical Models:Analysis of mathematical Models:Concepts of stability in multidimensional systems - Equilibrium points, limit cycles, Eigenvalues of the Jacobian matrix

Course Outcome:

1. *Ability to solve optimization using MATLAB***.**
2. *Application in process development*

Text Books:

1. Wayne Bequette.B, Process dynamics Modeling and analysis and simulation,. PrenticeHallInc, 2004.
2. John H. Seinfeld and Leon Lapidus., Mathematical Methods in Chemical Engg., (Vol. 3),Process Modeling, Estimations and Identification. Prentice Hall, 1974.
3. Volesky.B and J. Votruba., Modeling and Optimization of Fermentation Process (Process Simulation and Modeling).Elsevier Science and Technology, 1992.

References:

1.Dynamic Moduleels in Biology By Stephen P. Ellner, John Guckenheimer.

2. Katok, A. B. and B. Hasselblatt (1999). Introduction to the Modern Theory of Dynamical Systems. Cambridge, CambridgeUniversity Press

3. Izhikevich E.M. (2007) Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting. The MIT Press, Cambridge, MA

COURSE PLAN

COURSE NO: 07BT62082 **COURSE TITLE: BIOPROCESS MODELS: DESIGN AND STABILITY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Aspects of Modeling in bioprocess industries: Basic classifications, fundamental features of Models: Knowledge-based and data based Models, unstructured and structured Models, compartmental Models, metabolic network Models, fuzzy logic, hybrid Models	8	15
MODULE : 2 Uses and limitations of mathematical Models : Illustrations of algebraic equations, ordinary differential equations, difference equations partial differential equations, integral equations and integro-differential equations. Importance of probability and Stochasticity in biological processes. Introduction to chaos	6	15
FIRST INTERNAL TEST		
MODULE: 3 Characteristics of a dynamical system**:** State-space representations: state variables and parameters, input and output vectors, state evolution. Linear and non-linear systems. Popular examples like Monad Model, Lotka-Volterra systems	6	15
MODULE: 4 Numerical methods for solving a linear system:General form of a linear system , Concepts of numerical techniques : Newton's method, Euler Integration, Runge-Kutta Integration, MATLAB integration routines**.** Linearization of non-linear Models and its interpretation: basic concepts	6	15
SECOND INTERNAL TEST		
MODULE : 5 Development of mathematical Models:Material and energy balances - Design parameters and tuning parameters - developing equations for process rates from first principles**.**Concepts in optimization for parameter estimation: Objective function, convex problems, parameter search space - local and global optimums, stationary points, Hessian matrix, Necessary and sufficient conditions for optimality, constraints, Lagrange multipliersDesign of experiments for parameter estimation - Accuracy of parameter estimates: sensitivity analysis. Concepts in parameter identifiability	10	20

MODULE : 6 Analysis of mathematical Models:Concepts of stability in one dimensional systems - Equilibria, convergence, eigenvalues, attractors and basin of attraction, bistability, phase portraits, bifurcation Concepts of stability in multidimensional systems - Equilibrium points, limit cycles, eigenvalues of the Jacobian matrix.	6	20
END SEMSETER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62084

Course Title:FOOD PROCESSING TECHNOLOGY

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Understand the basics of manufacturing of food products of consistent quality and nutritional value at affordable cost*
- *Develop skilled and competent manpower for food processing industries*

Course Content/ Syllabus:

Food as Source of Nutrients - Effect of processing on food proteins, Food additives.food microbiology-preservation techniques-Food storage Food packaging-Units Operations in Food Processing Industry. Microbial spoilage and methods of control of fruits and vegetables. Factors causing food spoilage, Food Preservation Hydrothermal treatment of grains-concepts of Food Quality-Quality assurance

Course Outcome:

1. *Explain the spoilage and deterioration mechanisms in foods and methods to control deterioration and spoilage*
2. *Describe the transport processes and unit operations in food processing as demonstrated both conceptually and in practical laboratory settings.*
3. *Explain the properties and uses of various packaging materials.*
4. *An updated knowledge about maintenance of food quality control aspects*

Text Books:

1. Food Chemistry by L H Meyor (CBS Publisher, Delhi)
2. Modern Food Microbiology, James M. Jay, CBS Publishers & Distributors, Delhi.
3. Food Engineering Fundamentals, J.Clair Batty, Steven L Folkman, John Wiley& Sons.
4. Fundamentals of Food Process Engineering, Romeo Toledo, Van NostrandReinhold, New York

References:

1. Food Microbiology, W C Frazier and D C Westhoff, McGraw Hill Book Company, NY.
2. Post harvest technology of Cereals, Pulses and Oilseeds by Chakravarti A. Oxford Publishing.
3. Cereal Technology by Potter NN. AVI Publication.
4. Unit Operations of Agricultural Processing, K.M.Sahay&K.K.Singh, VikasPublishing House.
5. Engineering of Dairy & Food Products, A.W.Farral.

COURSE PLAN

COURSE NO: 07BT62084 **COURSE TITLE: FOOD PROCESSING TECHNOLOGY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Food as a Source of Nutrients: sources and function of lipids, carbohydrates, proteins and minerals. Effect of processing on food proteins, Food additives.	6	15
MODULE: 2 Significance of microorganisms in foods. Chemical		

& Microbial Kinetics in Food Products, Nutrient preservation. Food packaging materials. Introduction to Units Operations in Food Processing Industry, Radiation sensitivity of micro-organisms, Effect of ionizing radiation on nutrients	6	15
FIRST INTERNAL TEST		
MODULE: 3 Food storage requirements and methods. Microbial spoilage and methods of control of fruits and vegetables. Pasteurization of milk and defects in milk and milk products. Microbiology of Canned Foods	6	15
MODULE: 4 Hydrothermal treatment of grains, Parboiling and milling of paddy,Dry and wet milling of corn, Modern methods of milling of pulses. Factors affecting milling of pulses	6	15
SECOND INTERNAL TEST		
MODULE: 5 Engineering Properties of Food Materials: Mechanical, Physical &Rheological properties. Food Spoilage & Control: Factors causing food spoilage, Food Preservation by use of Low Temperature, High temperature and Drying	8	20
MODULE: 6 General concepts of Food Quality, Safety and Management Systems, General principles of food hygiene – Quality assurance: GPs, HACCP system for food quality, ISO . Case studies.	10	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62086

Course Title:METABOLIC ENGINEERING

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *To understand and utilize cellular pathways for chemical transformation, energy transduction, and supramolecular assembly*
- *Purposeful alteration and manipulation of metabolic pathways for industrial applications.*

Course Content/ Syllabus:

Prokaryotic and Eukaryotic cell structures; pure culture techniques-Different media (simple, complex and defined) - Growth curve-Bioenergetics, Metabolism of Biomolecules-, Metabolic engineering in practice: Concept of directed cellular energy utilization –analytical and synthetic elements of metabolic engineering-Application of pathway manipulations

Course Outcome:

1. *Have acquired in depth knowledge on metabolic pathways and their regulation and on how metabolic pathways can be engineered for the improvement of various bioprocesses.*

Text Books:

1. G Stephanopoulos et al; *Metabolic Engineering principles & Methodologies*
2. T. Scheper R Faurie, J. Thommel*Advance in Biochemical engineering Biotechnology:Microbila production of L – Aminoacid*

References:

1. Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 7/e, 2007. McGraw Hill, Boston.
2. Fundamental Principles of Bacteriology, A.J. Salle, 1999. Tata McGraw - Hill Publishing Company Limited, New Delhi.
3. Microbial Ecology. Fundamentals and Applications, R. M. Atlas and R. Bartha, 2000.
4. Microbiology, M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, 1993. McGraw Hill Inc., New York.
5. Biochemistry, 4th edition, L.Stryer., 1999. W.H, Freeman & company, New York.
6. Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox., 1993. Worth Publishers, New York.
7. Biochemistry 4th edition, G. Zubay, 1998. McMillan Publishing Co. New

COURSE PLAN

COURSE NO: 07BT62086 **COURSE TITLE: METABOLIC ENGINEERING** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Prokaryotic and Eukaryotic cell structures; pure culture techniques- isolation, cultivation, enumeration and preservation of microbes; staining techniques- simple and differential staining. Nutritional requirements and nutritional grouping of microorganisms; Different media (simple, complex and defined)	6	15
MODULE: 2 Growth curve; Axenic culture, Synchronous culture, Continuous culture; Different; Effects of physical and chemical factors on microbial growth. Microbial genetics-recombination - transformation, transduction, conjugation, regulation of gene expression. Bioenergetics, Metabolism of Carbohydrates, Proteins, Amino acids, Lipids and Nucleic acids-their biosynthesis and degradation	8	15
FIRST INTERNAL TEST		
MODULE: 3 Integration of carbohydrate and fatty acid metabolism. Mechanism of oxidative phosphorylation and its inhibitors, and photophosphorylation, urea cycle, hormonal regulation of mammalian metabolism. Heterocylic compounds and secondary metabolites - prostaglandins, leukotrienes, thromboxanes, interferons and interleukins, antibodies, alkaloids, plant and animal pigments	8	15
MODULE: 4 Metabolic engineering in practice: Concept of directed cellular energy utilization –analytical and synthetic elements of metabolic engineering – targets of metabolic engineering. Strategies for redirecting branched and linear pathways: (Alteration of feed back regulation; limiting accumulation of end product feed back resistant mutants, alteration of permeability).	6	15
SECOND INTERNAL TEST		
MODULE : 5 Metabolic Flux Analysis: Concept and utility of MFA – Theory – case studies – over determined systems – experimental determination of MFA by isotope labeling – applications of MFA: Case studies- concept & fundamentals of metabolic control analysis. Application of pathway manipulations: Strategies for overproduction of primary metabolites.	8	20

MODULE: 6 Strategies for overproduction of secondary metabolites (precursor effects, prophophaseidiophase relationship, enzyme induction, feed back regulation.) Bioconversions: (ME concepts applied in process decisions for enhanced bioconversion). Examples of pathway manipulations: Enhancement of product yield (alcohol, amino acids) – extension of substrate ranges (lignocelluloses utilization) – extension of product spectrum (antibiotic, biopolymers) - improvement of cellular properties (alteration of metabolism, enhanced efficiency and yield, genetic stability).	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62088
Course Title:BIO PROCESS MODELLING AND SIMULATION
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *To give student an understanding of Process Modeling and Simulation*

Course Content/ Syllabus:

Elements of probability theory-Perspective on Modeling of physical, chemical and biological phenomena-mathematical Models in Bioprocess Model-Mathematical Models for mixing vessel- Review of numerical techniques for the solution of bioprocess Models.-Introduction to population balance Modeling in bioprocess engineering.

Course Outcome:

1. *Develop model equations for a given system*
2. *Demonstrate model solving ability for various processes/unit operations*

Text Books:

1. John H. Seinfeld and Leon Lapidus., *Mathematical Methods in Chemical Engg., (Vol. 3), Process Modeling, Estimations and Identification*. Prentice Hall, 1974.

2. Luyben W.L., *Process Modelling, Simulation and Control for Chemical Engineers*, McGraw Hill International Edition

References:

1. Ramakrishna. D, *Population Balances.* Academic Press, 2000
2. Biquette W.B., *Process Dynamics - Modeling Analysis and Simulation*, Prentice Hall
3. Volesky.B and J. Votruba., *Modeling and Optimization of Fermentation Process (Process Simulation and Modeling)*. Elsevier Science and Technology, 1992.
4. Biquette W.B., *Process Dynamics - Modeling Analysis and Simulation*, Prentice Hall of India.

COURSE PLAN

COURSE NO: 07BT62088 **COURSE TITLE: BIO PROCESS MODELLING AND SIMULATION** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Perspective on Modeling of physical, chemical and biological phenomena, uses and limitations of mathematical Models in Bioprocess Models- Basic classifications, fundamental features of Models.	6	15
MODULE : 2 Examples involving algebraic equations, ordinary differential equations, difference equations partial differential equations, integral equations and integro-differential equations. Elements of probability theory, stochastic Models parameter estimation Model forms for parameter estimation.	8	15
FIRST INTERNAL TEST		
MODULE: 3 Parameter estimation using moments, design of experiments for parameter estimation. Accuracy of parameter estimates. Design of experiments for Model discrimination - Regression and interpolation	6	15
MODULE : 4 Mathematical Models for mixing vessel- mixing with reaction - reversible reaction- steam jacketed vessel- isothermal constant and variable hold up CSTR in series- Boiling of single component liquid-open and closed vessel - continuous flow boiling. Multi-component boiling system - batch distillation-condensation.	8	15
SECOND INTERNAL TEST		

MODULE: 5 Review of numerical techniques for the solution of bioprocess Models. Non linear systems analysis Phase – Plane analysis in classical bioreactor Models, Introduction to population balance Modeling in bioprocess engineering – The solution of population balance equations.	8	20
MODULE: 6 Budding of yeast population – Modeling of cells with dynamic morphology – Modeling for biological populations with correlation between life spans of siblings. Modeling of Industrial sterilization processes	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

ELECTIVE III

07BT6210X

Course No: 07BT62102

Course Title:MOLECULAR DIAGNOSTICS

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Understanding the molecular basis of diseases and techniques involved in diagnosis of diseases*.

Course Content/ Syllabus:

Host pathogen interactions in disease processMolecular techniques for analysis of Biochemical, Immune, Genetic disorders.Monoclonal antibodies as diagnostic reagents Development of molecular diagnostic technology.-Molecular techniques for diagnosis-DNA sequencing and diagnosis ,biosensors and nanotechnology.. OIE guidelines in development of diagnostics. Present methods for diagnosis of Specific diseases. Current issues and opportunities in the diagnostic sector

Course Outcome:

1. *Describe the laboratory techniques used to detect: microorganisms, inherited disease, DNA polymorphisms, neoplastic processes, DNA based tissue typing.*
2. *Outline the quality assurance process required in a molecular diagnostic laboratory.*

Text Books:

1. Fundamentals of Molecular Diagnostic Paperback – 1 Jan 2007by Carl A. Burtis , David Bruns, Edward R. Ashwood

2. Tietz Textbook of Clinial Chemistry and Molecular Diagnostics Hardcover – 1 Jan 2012by Carl A. Burtis

References:

1. Elles R &Mountford R. 2004. *Molecular Diagnosis of Geneti Disease*. Humana Press.
2. Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics* Horizon Bioscience.
3. Andrew Read and Dian Donnai, *New clinical Genetics*, Scion Publishing Ltd, Oxfordshire, UK, 2007.
4. James W Goding, *Monoclonal antibodies: Principles and Practice*, 3rd Edition, Academic Press, 1996.

COURSE PLAN

COURSE NO: 07BT62102 **COURSE TITLE: MOLECULAR DIAGNOSTICS** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Host pathogen interactions in disease process. Clinical diagnosis of diseases. Introduction and historical perspective of development of molecular diagnostic technology. Cancer biomarkers.	6	15
MODULE : 2 Concept of development of group specific and strain specific nucleic acid based diagnostics, basis for selection of gene/nucleotide sequence of pathogenic organism to target for detection. Molecular techniques for analysis of Biochemical, Immune, Genetic disorders.	6	15
FIRST INTERNAL TEST		
MODULE : 3 Application of restriction endonuclease analysis for identification of pathogens. Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents. Diagnosis of infectious diseases by using ELISA and Western blot.	6	15
MODULE : 4 DNA sequencing and diagnosis , Theoretical background of development of PCR and Real time PCR and its variations, application of PCR for diagnosis of infectious diseases of animals and poultry, nucleic acid sequence based diagnostics.	8	15
SECOND INTERNAL TEST		
MODULE : 5 Array based techniques in diagnosis (DNA & Protein array); single nucleotide polymorphism and disease association; Two dimensional gene scanning. Diagnostic technology based by biosensors and nanotechnology.	8	20
MODULE : 6 OIE guidelines in development of diagnostics. Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis. Current issues and opportunities in the diagnostic sector.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62104

Course Title:BIOREACTOR DESIGN

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Learn the basic and advanced principles of a designing a reactor for industrial applications*

Course Content/ Syllabus:

Introduction and Review of Bio-reaction engineering concepts-Modeling of non-ideal behavior in bio reactors-Continuous Stirred Tank Bioreactor-Fed–batch reactor-Recycle system-The Transient Behavior of Bioreactors-Design of a fermenter-Instrumentation and control-structured and unstructured Models for bioprocess systems.

Course Outcome:

1. *Estimate values for process variables using suitable correlations and equations developed from first principles.*
2. *Formulate sensitivity analysis on bioreactor systems and determine optimum operating parameters.*

Text Books:

1. Chemical Reaction Engineering - Octave Levenspiel
2. Elements of Chemical Reaction Engineering - H. Scott Fogle
3. Biochemical Engineering Fundamentals - James E. Bailey, David F. Ollis

References:

1. Bioprocess Engineering Principles - Pauline M.Doran
2. Bioprocess Engineering Basic Concepts - Michael L. Shuler, FikretKarg.

COURSE PLAN

COURSE NO: 07BT62104 **COURSE TITLE: BIOREACTOR DESIGN** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Introduction and Review of Bio-reaction engineering concepts, Mass transfer effects in heterogeneous reaction, Continuous stirred tank and plug flow reactor performance equations. Modeling of non-ideal behavior in bio reactors- problem and solution. Tanks in series Model. Dispersion Models with chemical reaction. Applications to design of continuous sterilizers – problems and solution.	8	15
MODULE : 2 Continuous Stirred Tank Bioreactor **:** performance equation for M-M kinetics, substrate inhibition kinetics and product inhibition kinetics, chemostat with cell cultures –steady state cell and substrate concentrations and productivity as a function of dilution rate, CSTR with immobilized enzymes, operation of CSTR in a constant feed rate policy	6	15
FIRST INTERNAL TEST		
MODULE : 3 Fed–batch reactor: Applications of fed reactor, Fed batch operation of mixed reactor, material balance on cell and substrate **Recycle system**: Chemostat with recycle, Biological waste water treatment, Feed forward control of the activated sludge process	6	15
MODULE : 4 The Transient Behavior of Bioreactors: Stability analysis, Stability of the chemostat, Stability of chemostat with substrate inhibition, Operating diagram, Transient responses of the chemostat, control of the chemostat, Instrumentation and control of bioreactor: Methods of measuring process variables, measurement and control of dissolved oxygen, pH measurements	6	15
SECOND INTERNAL TEST		
MODULE : 5 Design of a fermenter: Basic function of a fermenter for microbial or animal cell culture, basic bioreactor design criteria, overview of bioreactor types-stirred tank bioreactor, bubble column bioreactor, air-lift reactor, propeller loop reactor, jet loop reactor, schematic overview of a fermenter with control system, operating issues that affect reactor design, aeration and oxygen mass transfer in bioreactor system, design of chemostat	10	20
MODULE: 6 Introduction to structured and unstructured Models for bioprocess systems. Structured compartment Model – Williams and Ramakrishna Model ,single cell Model, metabolic Model, Genetically structured Model, Model simulation using MATLAB, Simulink.	6	20

END SEMESTER EXAMINATION

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62106

Course Title:GENOMICS& PROTEOMICS

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *Understanding structural, functional and comparative genomics its application for health applications and drug discovery*

Course Content/ Syllabus:

Human Genome Project-cloning-vectors-DNA batabanks-coding sequences-Protein sequence information-protein databanks-Tools and techniques in proteomics-3-dimensional structure determination-.Phylogenetic analysis.

Course Outcome:

1. *Use the different methodologies, techniques and tools commonly used in proteomics and genomics.*

Text Books:

1. Bioinformatics; Methods and applications; Genomics, Proteomics and Drug Discovery; (Rastogi, S. C. and Mendiratta and Rastogi, P)
2. Bioinformatics; A practical guide to the analysis of genes and proteins.; Edited by, Andreas D. Baxevanis and Francis Oulelette

References: _

1. Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
2. Primrose SB &Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
3. Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley-CVH.

COURSE PLAN

COURSE NO: 07BT62106 COURSE TITLE: GENOMICS & PROTEOMICS (L-T-P :3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences. Sequence databases: Gene Bank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), database formats	6	15
MODULE:2 Recombinant DNA technology, restriction enzymes, resource for restriction enzyme (REBASE), similarity search. Polymerase chain reaction, primer selection for PCR, BLASTn, application of Bio Edit.Genome information and special features, coding sequences (CDS), un-translated regions (UTR's),	6	15
FIRST INTERNAL TEST		
MODULE: 3cDNA library, expressed sequence tags (EST). Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. Internet resources for gene identification, detection of functional sites, gene expression. Introduction, Basic steps for gene expression	6	15
MODULE: 4 Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments. Protein sequence information, composition and properties, physic chemical properties based on sequence, sequence comparison, Primary and Secondary databases. Pair-wise sequence alignment, gaps, gap-penalties,	8	15

scoring matrices, PAM250,BLOSUM62, local and global sequence alignment, multiple sequence alignment, useful programs, ClustalW, BLASTp		
SECOND INTERNAL TEST		
MODULE : 5 Proteomics classification; Tools and techniques in proteomics; 2-D gelelectrophoresis, gel filtration, PAGE, isoelectric focusing, affinity chromatography, HPLC, ICAT, fixing and spot visualization, Mass spectroscopy for protein analysis, MALDI-TOF,	8	20
MODULE: 6 Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS)analysis; tryptic digestion and peptide fingerprinting (PMF), Protein Micro array inproteinexpression, profiling and diagnostics, drug target discovery. Database searching, 3-dimensional structure determination by X-ray and NMR. Phylogenetic analysis	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT62108
Course Title: BIOFUEL ENGINEERING
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *To understand the concepts, systems, and technology now being used to produce biofuels on both an industrial and small scale*

Course Content/ Syllabus:
Biofuels-Biofuel Production-Production of Biohydrogen-Production of Bioethanol-Production of Biodiesel-Microbial Fuel Cells-Design and Treatment Effectiveness-Microbial Modeling of Biofuel Production.

Course Outcome:

1. *Develop experimental plan and conduct lab works pertinent to biofuel production.*

Text Books:

1. Caye M. Drapcho, N.P. Nhuan and T. H. Walker, *Biofuels Engineering Process Technology* , McGraw Hill Publishers, New York, 2008.
2. Jonathan R.M, *Biofuels – Methods and Protocols (Methods in Molecular Biology Series),* Humana Press, New York, 2009.

References:

1. Lisbeth Olsson (Ed.), *Biofuels (Advances in Biochemical Engineering/Biotechnology Series,* Springer-Verlag Publishers, Berlin, 2007

COURSE PLAN

COURSE NO: 07BT62108 COURSE TITLE: BIOFUEL ENGINEERING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Introduction:Description of Biofuels; Energy Use & Efficiency; Biofuel Production; Alternative Energies; Biochemical Pathways Review for Organoheterotrophic, Lithotrophic& Phototrophic Metabolism; Importance of COD; Biofuel Feedstocks: Starch, Sugar, Lignocellulosic, Agro & Industrial by-products.	6	15
MODULE : 2 Production of Biohydrogen:Enzymes involved in H2 Production; Photobiological H2 Production: Biophotolysis and Photofermentation; H2 Production by Fermentation: Biochemical Pathway, Batch Fermentation, Factors affecting H2 production, Carbon sources, Process and Culture Parameters; Detection and Quantification of H2	6	15
FIRST INTERNAL TEST		
MODULE : 3 Production of Bioethanol:Process Technology for Bioethanol production using Sugar; Starch and LignocellulosicFeedstocks: Selection of micro-organisms and feedstock; Associated Unit Operations; Determination of Bioethanol yield; Recovery of Bioethanol; Recent Advances; Process Integration	6	15
MODULE : 4 Production of Biodiesel**:** Chemical,		

Thermodynamic & Reaction Kinetic Aspects of Biodiesel Production: Transesterification and Supercritical Esterification, Saponification and Hydrolysis, Acid & Base Catalysis; Sources of Oils; Methods of Biodiesel Production – General procedure and Large scale production; Quality Control Aspects.	6	15
SECOND INTERNAL TEST		
MODULE : 5 Microbial Fuel Cells:Biochemical Basis; Fuel Cell Design: Anode & Cathode Compartment, Microbial Cultures, Redox Mediators, Exchange Membrane, Power Density; MFC Performance Methods: Substrate & Biomass Measurements, Basic Power Calculations, MFC Performance: Power Density, Single-Chamber vs Two-Chamber Designs, Wastewater Treatment Effectiveness; Future Directions	10	20
MODULE : 6 Microbial Modeling of Biofuel Production: Microbial Growth Moduleels: Unstructured, Single Limiting Nutrient Models, Inhibition Models, Models for Multiple Limiting Substrates, Yield Parameters; Kinetic Rate Expressions; Bioreactor Operation and Design for Biofuel Production: Batch, CSTR, CSTR with Cell Recycle, Fed-Batch Systems, Plug Flow Systems; Modeling of Glucose Utilization and Hydrogen Production; Batch and CSTR Fermentations and Simulations .	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

ELECTIVE IV

07BT7201X

Course No: 07BT72011
Course Title:ADVANCED BIOSEPARATION TECHNIQUES
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Understand the principles and theory of Chromatography, mechanism of interaction and its applications in separation and analysis biomolecules such as proteins, peptides and small molecules of therapeutic importance.*

Course Content/ Syllabus:

Role of Downstream Processing in Biotechnology: Role and importance of downstream processing in biotechnological processes. Economics and downstream processing in Biotechnology. Physicochemical basis of bio-separation processes. Precipitation & Extraction methods: Precipitation with salts, organic solvents &polymers. Membrane-based separations (micro- & ultra-filtration) Principles of chromatographic separation Case studies: Preparation of commercial enzymes

Course Outcome:

1. *To understand the importance of downstream processing in Biotechnology*
2. *To familiarise with precipitation and extraction methods*

References

1. Belter P.A, Cussler E and Wei Shan Hu, *Bioseparation – Downstream Processing for Biotechnology*, Wiley Interscience, 1988.
2. Asenjo and Juan A. Asenjo, *Separation Processes in Biotechnology*, CRC Press, 1990.
3. Wankat P.C, *Rate Controlled Separation*, Kluwer Publishers, 1990.
4. Wang D.I.C, Cooney C.L, Demain A.L, Dunnil.P, Humphery A.E. and Lilly M.D. *Fermentation and Enzyme Technology*, John Wiley and Sons, 1979.

COURSE PLAN

COURSE NO: 07BT72011 COURSE TITLE: ADVANCED BIOSEPARATION TECHNIQUES (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE: 1 Role of Downstream Processing in Biotechnology: Role and importance of downstream processing in biotechnological processes. Problems and requirements of bio-product-purification. Economics and downstream processing in Biotechnology. Cost cutting strategies, characteristics of biological mixtures, process design criteria for various classes of bio-products (high volume-low value products and low volume- high value products),	10	15
MODULE: 2 Physicochemical basis of bio-separation processes. Primary Separation and Recovery Processes**:** Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, centrifugation and filtration methods	8	15
FIRST INTERNAL TEST		
MODULE: 3 Precipitation & Extraction methods: Precipitation with salts, organic solvents &polymers. Batch extractions, staged extractions-cross current, co current, counter current extractions. Differential extractions, fractional extractions with a stationary phase, fractional extractions with two moving phases. Reverse micelle extraction, supercritical fluid extraction, in-situ product removal/integrated bioprocessing.	8	15
MODULE : 4 Membrane-based separations (micro- & ultra-filtration): Theory; design & configuration of membrane separation equipment; applications; reverse osmosis, dialysis, electro dialysis, Iso-electric focusing.	6	15
SECOND INTERNAL TEST		
MODULE : 5 Adsorption**:** Adsorption isotherms, industrial adsorbents, adsorption equipments for batch and continuous operations (co current and counter current), adsorption in fixed beds.	4	20

MODULE : 6 **Chromatography**: Principles of chromatographic separation – gel filtration, reversed phase, hydrophobic interaction, ion-exchange, expanded bed adsorption, bio affinity and IMAC, supercritical fluid chromatography. **Case studies:** Preparation of commercial enzymes: Continuous isolation of enzyme prolyl-t RNA synthetase from mung bean, Intracellular foreign proteins from recombinant *E.coli and* extracellular enzyme (protease) recovery; Purification of biosurfactants from fermentation broths.	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72013

Course Title:INTELLECTUAL PROPERTY RIGHTS (IPR) FOR A GLOBAL BIO-ECONOMY

Credits: 3-0-0:3

Year: 2015

Pre-requisites: Nil

Course Objectives:

- *An understanding of IPR and Patent Systems in India. Development of a global standardization of patenting and the emerging of economies based on IPR.*

Course Content/ Syllabus:

Introduction to Patent and other IPRs, Types of IP, Patentability requirements-inventive-step, industrial applicability and disclosure requirements Biotechnological Invention by documentation and Search, Precautions while patenting disclosure/non-disclosure, Drafting of Patent in field of Biotechnology Bioprospecting&BiopiracyBiopiracy case studies , TRIPS- Does it favour Global transfer of Biotechnology Agriculture and food security: Intellectual property rights and the trade in seeds; Genetic Use Restriction Technologies

Course Outcome:

1. *To better understand about the IPR and patenting systems in the field of Biotechnology*

References:

1. Kankanala. C., Genetic Patent Law & Strategy, 1stEdition,
2. BAREACT, Indian Patent Act 1970, Acts & Rules
3. Laurence Liang, *'Beyond Representation. The Figure of the Pirate'.* Available at:http://www.altlawforum.org/PUBLICATIONS/Beyond%20Representation.doc
4. Vandana Shiva, *Bioprospecting as Sophisticated Biopiracy* (2007) *Signs* 32(2): pp :307-313.
5. Convention on Biological Diversity, at: http://www.biodiv.org/convention/articles.asp
6. UNEP/CBD/WG-ABS/2/3, 2003, *`The Role of Intellectual Property Rights in Access and Benefit-Sharing Arrangements'* at: http://www.biodiv.org/doc/meetings/abs/abswg-02/official/abswg-02-03-en.pdf
7. Carlos Correa, *Traditional Knowledge and Intellectual Property: Issues and Options Surrounding Protection of Traditional Knowledge* (2001), available at: http://www.geneva.quno.info/pdf/tkmono1.pdf
8. Cori Hayden, *When Nature Goes Public. The Making and Unmaking of Bioprospecting in Mexico* (Princeton: PrincetonUniversity Press, 2003.
9. Drahos 'Negotiating Intellectual Property Rights. Between Coercion and Dialogue' in Drahos&Mayne (eds), *Global Intellectual Property Rights* (2002) 161-182.
10. Graham Dutfield, *Intellectual Property Rights and the Life Science Industries. A Twentieth-Century History* (2003), chapter 8.
11. Glen Burgos & Dan Kevles, Plants as Intellectual Property: American Practice, law, and policy in World Context (1992) 7 *Osiris* 74-104.
12. Michael Blakeney, 'Stimulating Agricultural Innovation', in Maskus& Reichmann, *International Public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, chapter 14.
13. BiswajitDhar, Sui generis systems for plant variety protection, available at:http://www.geneva.quno.info/pdf/sgcol1.pdf
14. PrabuddhaGanguli*IntellectuaIProperty Rights-Unleashing the Knowledge Economy*. Tata McGraw Hill Publishing Company Limited, New Delhi.
15. Beier, F.K, Crespi, R.S and Straus, T. *Biotechnology and Patent protection* –Oxfordand IBH Publishing Co. New Delhi.
16. SassonA, *Biotechnologies and Development*, UNESCO Publications.

COURSE PLAN

COURSE NO: 07BT72013 COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS (IPR) FOR A GLOBAL BIO-ECONOMY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Introduction to Patent and other IPRs, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications**.** Patent protection, Patentability requirements-inventive-step, industrial applicability and disclosure requirements.	8	15
MODULE : 2 Biotechnological Invention by documentation and Search, Drafting of Patent in field of Biotechnology, Patent filing in India and in abroad, Successful research and commercialization of biotechnological inventions	6	15
FIRST INTERNAL TEST		
MODULE : 3 Precautions while patenting disclosure/non-disclosure, Patent infringement- meaning, scope, litigation. Diamond VS Chakrabarty Case. Orphan Drugs and diseases, The 90/10 research gap, Effect of TRIPS on drug prices in the developing world.	6	15
MODULE : 4 The International Debate on Traditional Knowledge as Prior Art in the Patent System', Bioprospecting&Biopiracy, Biopiracy case studies (Case studies of Neem /Turmeric/Arogyapacha of KaniTribals in Kerala/Rosy Periwinkle of Madagascar)-Traditional Knowledge Digital Library- Need and Development.. CBD as a treaty for protecting Traditional Knowledge.	8	15
SECOND INTERNAL TEST		
MODULE: 5TRIPS- Does it favour Global transfer of Biotechnology? CBD and the need of CBD for global developing countries. Regime shifting between TRIPS and Other agreements in Global lawmaking.' Industry Strategies for Intellectual Property and Trade: The Quest for TRIPS and Post-TRIPS Strategies'	8	20
MODULE: 6 Agriculture and food security: Intellectual property rights and the trade in seeds; Genetic Use Restriction Technologies-Terminator and Traitor technology. UPOV Treaty- disadvantages for India, Indian PPVFR Act 2001.Criteria for Plant variety (Novelty, Distinct, Unique, Stable)	6	20

END SEMESTER EXAMINATION

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72015
Course Title:MOLECULAR MODELLING & DRUG DISCOVERY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

To understand the various molecular Modeling structures. To understand the basic principles underlying drug design designing methods

- **Course Content/ Syllabus:**

Modeling basics. Generation of 3D Coordinates Crystal data, Fragment libraries Solvent effects and Quantum Mechanical methods Conformational analysis Computational tools for Molecular Modeling, conformational analysis using - Systematic Search Procedures, Monte carlo and molecular dynamics methods Force field, quantum chemistry, Schrödinger equation, potential energy functions, energy minimization Analog based drug design, Drug discovery area, pharmaco genetics and pharmacogenomics applications, computer-aided drugdesigning methods.

Course Outcome:

1. *To familiarise with molecular modelling and simulation principles and softwares*

References:

1. Principles and applications of Modeling by Leach
2. Molecular Modeling by the Hans Peter Heltie&GerdFalkens, VCH.
3. Chemical application of molecular modeling,Jonathan Goodman.
4. Computational chemistry by Guy H Grant & W.Graham,Oxford University

COURSE PLAN

COURSE NO: 07BT72015 COURSE TITLE: MOLECULAR MODELLING & DRUG DISCOVERY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
MODULE : 1 Modeling basics. Generation of 3D Coordinates Crystal data, Fragment libraries, and conversion of 2D Structural data into 3D Form, Force fields, and Geometry optimization, Energy minimizing Procedures, use of Charges, Solvent effects and Quantum Mechanical methods. Conformational analysis.	6	15
MODULE: 2 Computational tools for Molecular Modeling, conformational analysis using - Systematic Search Procedures, Monte carlo and molecular dynamics methods. Determining features of proteins (Interaction potential, Molecular Electrostatic Potential, molecular interaction fields, properties on molecular surface and Pharmacophore identification. 3DQSAR Methods.	8	15
FIRST INTERNAL TEST		
MODULE : 3 Introduction, force field, quantum chemistry, Schrödinger equation, potential energy functions, energy minimization, local and global minima, saddle point, grid search, various approximations; LCAO, HF, semi-empirical calculations; single point calculations, full-geometry optimization methods, ZDO, MNDO, CNDO, NDDO, AM1,PM3, RM1, conformational search, Z-matrix, docking, molecular Modeling packages.	8	15
MODULE : 4 Comparative protein modeling: Modeling by Homology the alignment, construction of frame Work, selecting variable regions, side chain placement and refinement, validation of protein Models – Ramchandran plot, threading and ab initio modeling.	6	15
SECOND INTERNAL TEST		
MODULE: 5 Analog based drug design: Introduction to QSAR, lead Module linear and nonlinear Modeled equations, biological activities, physicochemical parameter and molecular descriptions, molecular Modeling in drug discovery.	6	20
MODULE : 6 Introduction, drug discovery area, pharmaco genetics and pharmacogenomics applications, SNPs, parameters in drug discovery identification of drug target molecules, drug design and its approaches, computer-aided drug designing methods; computer aided molecular design (CAMD), Quantum CAChe and project leader, ligand design methods, docking programs; De novo design	8	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72017
Course Title: FUNDAMENTALS OF SYNTHETIC BIOLOGY

Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Design and construction of new biological functions and systems not found in nature.*

Course Content/ Syllabus:
Introduction to Biotechnology and Synthetic Biology- History, Goals, Applications, and Methods Overview The Central Dogma of Biology.DNA Structure & Modification Processes Synthetic Biology: Design Paradigm (Parts, Devices, Systems) The importance of network structure in cellular networks .Review of continuous and stochastic Models of cellular networks Control systems in metabolism. Control systems in protein networks Metabolic engineering strategies. Protein networks, control and dynamical analysis

Course Outcome:

1. *To acquire knowledge about the basic concepts in synthetic biology, network structures in cellular level and control systems in metabolism.*

References:

1. Synthetic biology-Industrial and environmental applications by Markus Schmidt
2. System biology and synthetic biology by Pengcheng Fu &svenpanke.
3. The emergence of life- from chemical origins to synthetic biology By Pier Luigi Luisi.

COURSE PLAN

COURSE NO: 07BT72017 **COURSE TITLE: FUNDAMENTALS OF SYNTHETIC BIOLOGY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE :1 Introduction to Biotechnology and Synthetic Biology-History, Goals, Applications, and Methods Overview**,** Risks of engineered systems, Synthetic Biology Standards, ethics of the field	8	15
MODULE : 2 The Central Dogma of Biology.DNA Structure & Modification Processes. PCR Technology, DNA Sequencing & Synthesis Technology. Different application areas of engineered bacteria	8	15
FIRST INTERNAL TEST		
MODULE: 3 Synthetic Biology: Design Paradigm (Parts, Devices, Systems).Cloning. Cloning vs. Bio-Brick Assembly Process. Fundamental Engineering Concepts in Application to Synthetic Biology.	6	15
MODULE: 4 The importance of network structure in cellular networks .Review of continuous and stochastic Models of cellular networks. The interplay between structure and dynamics. Bifurcation analysis and evolutionary design approaches in synthetic biology. Standards and ontologies (SBML, CellML, PoBoL, CAD in synthetic biology).	8	15
SECOND INTERNAL TEST		
MODULE: 5 Control systems in metabolism. Control systems in protein networks. Robustness and small signal analysis of cellular pathways. Advanced structural analysis including elementary Models, FBA and MFA.	6	20
MODULE: 6 Metabolic engineering strategies. Protein networks, control and dynamical analysis. Protein network engineering.	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

ELECTIVE V

07BT7203X

Course No: 07BT72031
Course Title:TISSUE ENGINEERING & BIOMATERIALS

Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *To understand the basics to synthesize materials that can stimulate beneficial biological responses from the body and use them for tissue repair*

Course Content/ Syllabus:

Structure of solids. Review of basic concepts Biomaterials, definition, classification Structure property relation. Characterization of biomaterials.Tissue environment of the implanted biomaterial: unit cell processes Survey of clinical cases of biomaterials-tissue interactions, Tissue structures and unit cell processes Cell-surface interactions: Analysis of surfaces of biomaterials and protein adsorption, *In vivo* and clinical case studies: Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment *In vivo* synthesis of skin, In *vivo* synthesis of peripheral nerve, Rules for synthesis of tissues and organs, Joints and dental tissues

Course Outcome:

1. *To understand the applications of Tissue Engineering and basic concepts involved*
2. *To familiarise with various biomaterials used in tissue engineering.*

References

1. Ratner, Hoffman, Schoen *Biomaterial science- an introduction to materials in medicine*Academic press
2. Bernhard Palsson, Sangeeta Bhatia ,*Tissue Engineering*, Pearson Prentice Hall, 2003
3. Robert. P.Lanza, Robert Langer & William L. Chick, *Principles of tissue engineering*, Academic press,1997
4. Park .J.B. *Biomaterials- science and engineering*, Plenum press
5. Sharma C.P., Szycher.M*Blood compatible materials and devices* Technomic publishing company
6. R. M. Johnson, R. M. Mwaikambo, Tucker Biopolymers Rapra technology.

COURSE PLAN

COURSE NO: 07BT72031 COURSE TITLE: TISSUE ENGINEERING & BIOMATERIALS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Structure of solids. Review of basic concepts. Biomaterials, definition, classification. Polymers, metals, alloys, ceramics and composites, physical, chemical and mechanical aspects of bulk and surface properties of metallic ,polymer and ceramic biomaterials (in vivo and in vitro) Corrosion studies.	8	15
MODULE : 2 Structure property relation. Characterization of biomaterials. Bulk analysis-XRD, FTIR, SEM, TGA etc. Surface analysis-XPS, SIMS, AES, STM etc	6	15
FIRST INTERNAL TEST		
MODULE : 3 Tissue environment of the implanted biomaterial: unit cell processes Survey of clinical cases of biomaterials-tissue interactions, Tissue structures and unit cell processes, Integrins and adhesion proteins Unit cell processes comprising the healing response, Unit cell processes underlying tissue engineering, Structure and function of naturally occurring ECMs and its regeneration	8	15
MODULE : 4 Cell-surface interactions: Analysis of surfaces of biomaterials and protein adsorption, Phenotype changes following adhesion on biomaterials, Structural determinants of biologically active materials, Methodology for cell-surface interactions, Cell-scaffold interactions during regeneration, Non-cooperative cell-surface interactions, From randomness to co-operativity. Scaffold and transplant- Engineering biomaterials, Degradable materials, porosity, mechanical strength, 3-D architecture and cell incorporation.	8	15
SECOND INTERNAL TEST		
MODULE: 5 ***In vivo*** **and clinical case studies**: Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment. Tissue response to implants; biocompatibility, Epithelialization (epidermal regeneration) and endothelialization of vascular prostheses,	6	20
MODULE: 6 *In vivo* synthesis of skin, In *vivo* synthesis of peripheral nerve, Rules for synthesis of tissues and organs, Joints	6	20

and dental tissues: prosthetic replacement, Implants for bone regeneration, Regeneration of soft musculoskeletal tissues, Biomaterial applications in the heart and other organs. Ethical, FDA and regulatory issues.		
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72033
Course Title:NANOBIOTECHNOLOGY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Provide basic knowledge in the interface between chemistry, physics and biology on the nano structural level with a focus on biotechnological usage*

Course Content/ Syllabus:

The Science of Nano - What is Nanobiotechnology, Cellular nanostructures Introduction to Nanostructures : Carbon Nanotubes (CNT), Fullerenes (C60, C300) Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles) Protein-based Nanostructures: Nanomotors: Bacterial (*E.coli*) and Mammalian (Myosin family). Nanobiosensors: Science of Self-assembly - From Natural to Artificial Structures Nanotechnology & Microfluidics Nanoparticles: Synthesis and Applications. Applications of Nanostructures in Drug: Discovery, Delivery, and Controlled Release Nanotechnology for Tissue Engineering: Applications in Regenerative Therapy

Course Outcome:

1. *To understand the basic concepts in nanotechnology*

2. *To understand the significance of nanotechnology and its applications in the field of biotechnology*

References:

1. GeroDecher, Joseph B. Schlenoff, *Multilayer Thin Films*, Wiley-VCH Verlag GmbH & Co. KGaA, 2003
2. David S. Goodsell, *Bionanotechnology : Lessons from Nature*, Wiley-Liss , 2004.
3. Kenneth J. Klabunde , *Nanoscale Materials in Chemistry* , John Wiley & Sons, Inc., 2004
4. *Nanobiotechnology: Concepts, Applications and Perspectives* by Christof M. Niemeyer and Chad A. Mirkin Wiley-VCH; 1 edition, 2004

COURSE PLAN

COURSE NO: 07BT72033 **COURSE TITLE: NANOBIOTECHNOLOGY** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 The Science of Nano - What is Nanobiotechnology, Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles),	6	15
MODULE : 2 Introduction to Nanostructures : Carbon Nanotubes (CNT), Fullerenes (C60, C300) Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles), Nanowires Polymer-based Nanostructures (Dendrimers), Gold Nanostructures: (Nanorods, Nanocages, Nanoshells)	8	15
FIRST INTERNAL TEST		
MODULE : 3 Protein-based Nanostructures: Nanomotors: Bacterial (*E.coli*) and Mammalian (Myosin family). Nanobiosensors: Science of Self-assembly - From Natural to Artificial Structures. Nanoparticles in Biological Labeling and Cellular Imaging: Science of Nanoparticles Functionalization	6	15
MODULE : 4 Nanotechnology & Microfluidics: Nano Printing of DNA, RNA, and Proteins Biochips Applications in Nano Scale Detection, Lab-on-a-chip Devices (LOC), Medical Applications of Nanobiotechnology: Nanoparticles' Cytotoxicity.	8	15

SECOND INTERNAL TEST		
MODULE : 5 Nanoparticles: Synthesis and Applications. Applications of Nanostructures in Drug: Discovery, Delivery, and Controlled Release. Nanostructures in Cancer Research: Examples of Nanostructures in Research and Therapy.	8	20
MODULE : 6 Nanotechnology for Tissue Engineering: Applications in Regenerative Therapy. Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology.	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72035
Course Title:MANAGEMENT ENTREPRENEURSHIP & BIO-BUSINESS
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil
Course Objectives:

- *Impart technical knowledge and develop managerial skills for managing Bio - Technology business*
- *To promote entrepreneurship amongst students to venture in Bio - Technology business*

Course Content/ Syllabus:
Management: Introduction: Meaning nature and characteristics of Management, scope and functional areas of management Managing Engineering Design and Development: Product and Technology Life Cycles, Nature of Research and development, Research Strategy and organization Managing Production Operations Entrepreneur: Meaning of an Entrepreneur, Role of entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship Barriers Preparation of Project:Meaning of Project, Project Identification,

Project Selection, Project Report –Contents, Formulation and Project Appraisal Technologies and Bio-Safety: Principles of business management and concept of Bio-business Commercialization: Analysis of factor influencing international competitiveness in biotechnology Project Cost and Market Potential: Total product cost, capital investment and profitability

Course Outcome:

1. *To inculcate financial management and business skills.*

References:

1. R.A. Baron, S.A. Shane; Entrepreneurship, Thomson, 2004, ISBN 0-324-27356

2. Small Business Management: Entrepreneurship and Beyond, Timothy S Hatten

COURSE PLAN

COURSE NO: 07BT72035 **COURSE TITLE: MANAGEMENT ENTREPRENEURSHIP & BIO-BUSINESS** **(L-T-P : 3-0-0) CREDITS:3**		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Management: Introduction: Meaning nature and characteristics of Management, scope and functional areas of management, Management and administration, roles of management, levels of management. Development of Management Thought: Early management approaches and Modern management approaches. Functions of Management**:** Planning and Forecasting, Organizing, Directing and Controlling.	8	15
MODULE : 2 Managing Engineering Design and Development: Product and Technology Life Cycles, Nature of Research and development, Research Strategy and organization, selecting R & D Projects, Protection of Ideas. Creativity, Nature of Engineering Design, Systems Engineering / New Product Development, Control System in Design, Product Liability and Safety, Designing for Reliability, other "abilities" in Design. Managing Production Operations**:** Assuring product quality, Productivity, Work measurement, Maintenance and Facilities (Plant)	6	15

engineering and other manufacturing functions.		
FIRST INTERNAL TEST		
MODULE : 3 Entrepreneur: Meaning of an Entrepreneur, Role of entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship Barriers. Role of Micro Small & Medium Enterprises (MSME) in Economic Development, Impact of Liberalization, Privatization and Globalization on MSME, Effect of WTO/GATT. Different Schemes; TECSOK, KIADB, KSSIDC, KSIMC, DIC-Single Window Agency, MSME, NSIC, SIDBI, KSFC.	6	15
MODULE : 4 Preparation of Project: Meaning of Project, Project Identification, Project Selection, Project Report –Contents, Formulation and Project Appraisal. Identification of Business Opportunities: Market Feasibility studies, Technical Feasibility Studies; Financial Feasibility Studies and Social Feasibility studies.	8	15
SECOND INTERNAL TEST		
MODULE : 5 Technologies and Bio-Safety: Principles of business management and concept of Bio-business, Fundamentals and constituents of Biotech for bio-business, SWOT analysis of Indian Bio-business. **Commercialization:** Analysis of factor influencing international competitiveness in biotechnology, type of firms commercializing biotechnology, financing, tax incentives, issues and policies. Bioscience enterprises- raw bio-commodities, hybridization, tissue culture, bio-fermentation, bio-fertilizers.	8	20
MODULE : 6 Project Cost and Market Potential: Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, manufacturing cost estimation for an intracellular protein, using cost analysis for R & D decision making.	6	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60

Course No: 07BT72037
Course Title: STRUCTURAL BIOLOGY
Credits: 3-0-0:3
Year: 2015
Pre-requisites: Nil

Course Objectives:

- *Study protein and nucleic acid structure and function, focusing on energetic forces that guide folding, and computer Modeling to predict structures*

Syllabus:

Nucleic acid structures, RNA folding, RNA loops, conformational study, various ribose ring conformations Over expression of recombinant protein, Construction of an over expression system *In vivo* expression system:*Escherichia coli*, yeast (*S. cerevisiae, P. pastries* etc.), insect cells. *In vitro* expression system-cell-free system. Protein purification Crystallization: Crystallization techniques Protein Structure Prediction; Homology Modeling, prediction of protein structure from sequences Predicting trans-membrane helices

Course Outcome:

1. *To understand the biomolecules in structural and functional level*
2. *To understand the basic principles of modelling.*

References:

1. Introduction to Protein Architecture, by A.M.Leak
2. Introduction to Protein Structure, by Banden and Tooze.
3. Tinoco, Ignacio, Jr., Sauer, Kenneth, Wang, James C., & Puglisi, Joseph D. (2001) Physical Chemistry: Principles and Applications in Biological Sciences, 4th ed. Prentice Hall, ISBN: 0-13-095943-X
4. vanHolde, Kensal E., Johnson, W. Curtis, & Ho, PuiShing (1998) Principles of Physical Biochemistry. Prentice Hall. ISBN 0-13-720459-0
5. Cantor, Charles, and Schimmel, Paul (1980) Biophysical Chemistry, Vols. I-III, W. H. Freeman and company, San Francisc

COURSE PLAN

COURSE NO: 07BT72037 COURSE TITLE: STRUCTURAL BIOLOGY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact Hours**	**Sem.Exam Marks;%**
MODULE : 1 Nucleic acid structures, RNA folding, RNA loops, conformational study, various ribose ring conformations, ribose-ring puckering, protein-protein interactions, protein ligand interactions, DNA-binding proteins, RNA-binding proteins, Ramachandran plot, ,3-dimensional structures of membrane proteins, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids.	8	15
MODULE : 2 Over expression of recombinant protein, Construction of an over expression system : Cloning the gene encoding the target protein in cloning vector, Over expression of the protein as a recombinant protein using expression vector in appropriate host cells.	6	15
FIRST INTERNAL TEST		
MODULE : 3 *In vivo* expression system:*Escherichia coli*, yeast (*S. cerevisiae, P. pastries* etc.), insect cells. *In vitro* expression system-cell-free system. Protein purification: Sonication, Chromatography, Affinity chromatography, Gel filtration, Hydrophobic interaction chromatography, Ion exchange chromatography, Confirmation of the purity of the protein,	8	15
MODULE : 4 Crystallization: Crystallization techniques: Sitting drop vapor diffusion, Hanging drop vapor diffusion, Micro batch under oil, Dialysis. Data collection - X-ray diffraction data. Phase determination and calculation of electron density, Modeling and Structure Refinement,	8	15
SECOND INTERNAL TEST		
MODULE : 5 Protein Structure Prediction; Homology Modeling, prediction of protein structure from sequences, functional sites, Protein folding problem, protein folding classes, protein identification and characterization; AACompIdent, TagIdent, PepIdent and MultiIdent; PROSEARCH, PepSea, Pep MAPPER, Find Pept,	7	20

MODULE : 6 Predicting trans-membrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.	5	20
END SEMESTER EXAMINATION		

ACADEMIC ASSESSMENT/EVALUATION

		Maximum marks :100
Internal Assessment	Internal Exam 1	15
	Internal Exam 2	15
	Assignment/Mini Project/Tutorial	10
	End Semester Examination	60