Bachelor of Technology (Biotechnology),UIET,KUK
Credit-Based for the Academic Session 2023-24
MODIFIED SCHEME OF STUDIES/EXAMINATIONS(*Semester-V*)

S.No	CourseNo./Code	Subject	L:T:P	Hours/ Week	Credits	ExaminationSchedule(Marks)				Duration ofexam(Hours)
						Major /Test	MinorTest	Practical	Total	
1	PTC-301	Metabolic Engineering	2:0:0	2	2	75	25	0	100	3
2	PTC-303	Biophysical and Bioanalytical Techniques	2:0:0	2	2	75	25	0	100	3
3	PTC-305	Structural Biology	2:0:0	2	2	75	25	0	100	3
4	PTC-307	Bioprocess Engineering	2:0:0	2	2	75	25	0	100	3
5	PTC-309	Bioinformatics and Computational Biology	2:0:0	2	2	75	25	0	100	3
6	PTE-1*	Professional Elective-I	2:1:0	3	3	75	25	0	100	3
7	PTC-311	Bioinformatics and Computational Biology Lab	0:0:4	4	2		40	60	100	3
8	PTC-313	Biophysical and Bioanalytical Techniques Lab	0:0:3	3	1.5		40	60	100	3
9	PTC-315	Metabolic Engineering Lab	0:0:3	3	1.5	-	40	60	100	3
10	OTS-1**	Open Subject-I	2:0:0	2	2	75	25		100	3
11	ATU-301	Indian Constitution	2:0:0	2	2	75	25		100	3
12	PTS-301	Industrial Training	0:0:2	2	1		100		100	3
13	**ATU-903	Essence of Indian Traditional Knowledge	3:0:0	3		100	-	-	100	3
		Total	19:1:12	32	23	700	420	180	1300	

****ATU-903**isamandatory creditless course in which the student will be required to get passing marks in the major test.

Professional Elective-I*
PTE-301 Good Manufacturing and Lab Practices
PTE-303Genome Editing
PTE-305Biochemical and Enzyme Technology
PTE-307 Bioreactor Analysis and Design

Open Subject- I**
OTS-301 Biomaterial Technology
OTS-303 Internet of Things
OTS-305 Image Processing/MOOC Course
OTS-307 3D Printing & Design /MOOC Course``

BachelorofTechnology(Biotechnology),UIET,KUK
Credit-Based for the Academic Session 2023-24
***MODIFIED SCHEME OF STUDIES/EXAMINATIONS*(Semester-VI)**

S.No	CourseNo./Code	Subject	L:T:P	Hours/ Week	Credits	ExaminationSchedule(Marks)				Duration ofexam(Hours)
						MajorTest	MinorTest	Practical	Total	
1	PTC-302	Downstream Processing and Bioseparation Engineering	3:1:0	4	4	75	25	0	100	3
2	PTC-304	Synthetic and Systems Biology	2:1:0	3	3	75	25	0	100	3
3	PTC-306	Animal and Plant Biotechnology	2:1:0	3	3	75	25	0	100	3
4	PTC-308	Data Science in Genome Technology	3:0:0	3	3	75	25	0	100	3
5	PTE-II*	Professional Elective-II	2:1:0	3	3	75	25	0	100	3
6	OTS-II**	Open Subject-II	2:0:0	2	2	75	25	0	100	3
7	PTC-308 L	Data Science in Genome Technology Lab	0:0:2	2	1		40	60	100	3
8	PTC-310	Downstream Processing Lab	0:0:2	2	1		40	60	100	3
9	PTC-312	Animal and Plant Biotechnology Lab	0:0:4	4	2		40	60	100	3
10	PTS-302	Technical Seminar	0:0:2	2	1	-	100	0	100	3
11	HSMC-1	Elective-1***	3;0:0	3	3	75	25	0	100	3
		Total	17:4:10	31	26	525	395	180	1100	

Students shall have to select one elective from each group of Program Elective-II, Open Subjects-II and HSMC Elective-1.

Professional Elective-II*
PTE-302 Machine Learning
PTE-304 Waste Management and Upcycling
PTE-306 Stem Cell Technology
PTE-308 Nanobiotechnology

Open Subject- II**
OTS-302 Artificial Intelligence
OTS-304 Quantum Computing/MOOC Course
OTS-306 Cyber Security /MOOC Course
OTS-308 Design Thinking

HSMC Elective-1***
HSMC-301 Engineering Economics
HSMC-302 Management-1 (Organizational Behaviour)
HSMC-303 Operations Research
HSMC-304 Effective Technical Communication

PTC-301	Metabolic Engineering (B.Tech. Biotechnology) Semester- V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Purpose	**To familiarize the students with the Metabolic Engineering**						
Course Outcomes							
CO1	Students will analyze the complexities defining the regulation of various metabolic pathways.						
CO2	Students will able to learn about metabolic flux, and product formation.						
CO3	Students will able to design and learn strain-engineering strategies to alter cellular behavior.						
CO4	Learn industrial applications of metabolic engineering in the various fields.						

Unit I

Introduction to metabolic engineering and its importance: Introduction to metabolism, catabolism, anabolism. Key differences between metabolic controls of prokaryotes and eukaryotes. Stoichiometry of cellular reactions, enzyme kinetics, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, Different models for cellular Reactions-Induction-Jacob Monod Model and its regulation, Differential regulation by isoenzymes, concerted or cumulative feedback regulation. Regulation in branched pathways, permeability and transport of metabolites.

Unit II

Metabolic flux analysis: Building stoichiometric matrix; Steady state and pseudo steady state assumptions; using different optimizing functions to solve linear programming problem. Experimental determination of metabolic fluxes C13 labeling, NMR and GC-MS based methods for flux determination.

Unit III

Computational modelling of biological networks: Introduction to MATLAB. Synthetic circuit design, MOMA (Minimization of Metabolic Adjustment), iFBA (Integrated Flux Balance Analysis), dFBA; Enhancement of product yield and productivity. Strain selection and improvement, the modification of existing or the introduction of entirely new metabolic pathways

Unit IV

Industrial applications pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites (e.g. amino acids, organic acids, alcohols and therapeutic compounds).Bioconversion- applications and factors affecting bioconversion, mixed or sequential bioconversions.

Text Books/References:

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit.
3. The Metabolic Pathway Engineering Handbook by Christina D. Smolke.
4. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

PTC-303	Biophysical and Bioanalytical Techniques (B.Tech. Biotechnology) Semester-V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Purpose	**To acclimatize students about different bioanalytical techniques.**						
Course Outcomes							
CO1	Students will be able to understand the principle of microscopy.						
CO2	Able to understand the principle and applications chromatography techniques						
CO3	Students will be able to learn underlying principle and applications of spectroscopy.						
CO4	Students will be able to learn process of detection and measurement of radioactivity.						

UNIT- I

Principles of Microscopy: Light, electron (scanning and transmission), fluorescence microscopy.

Centrifugation: Basic concepts and applications, differential centrifugation, high speed and ultracentrifugation techniques.

UNIT- II

Electrophoresis: basic principle and applications of Paper and gel electrophoresis, isoelectric focussing, two-dimensional electrophoresis.

Principles of Chromatography: Ion-exchange, gel filtration, affinity, gas chromatography, High Pressure Liquid Chromatography (HPLC), FPLC and Hydrophobic Interaction Chromatography.

UNIT- III

Principle and applications of Spectroscopy: UV/visible, IR, NMR, ESR, fluorescence, Raman.

Mass spectroscopy: LC-MS, X-ray diffraction, CD.

UNIT- IV

Radioisotope Techniques: Nature of radioactivity, properties of α, β and γ-rays, detection and measurement of radioactivity, use of radioisotopes in research, autoradiography, radioimmunoassay.

Text/ References Books:

1. Physical Biochemistry, 2nd edition, by D Friefelder (1983). W.H. Freeman & Co., U.S.A.
2. Analytical Chemistry for technicians: John Kenkel (1994), Lewis Publishers. Boca Raton.
3. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalaya Publishing House, Delhi.
5. Physical Biochemistry, 2nd edition, by K. E. VanHolde (1985), Prentice Hall Inc, New Jersey.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

PTC-305	**Structural Biology (B.Tech Biotechnology Semester V)**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Purpose	To provide a solid foundation of understanding structural biology						
	Course Outcomes **After completion of course students will be able**						
CO 1	To explain the concept of protein sequences and sequence alignment						
CO 2	To use protein structures from protein data bank.						
CO 3	To explain the technique of Cryo Electron Microscopy.						
CO 4	To predict RNA secondary structure.						

Unit-I

Protein structural biology: Protein sequences, sequence alignment; basic polypeptide stereochemistry, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Chaperones assisted protein production, Protein structure and analysis: Principles of soluble and membrane protein purification.

Unit-II

Phase diagram and separation, crystallization, Use of robotics in crystallization, Space groups and symmetry, structure determination; NMR sample preparation, Sample preparation for Cryo EM, Structure validation and best practices on the use of protein structures from protein data bank.

Unit-III

Protein fold-function relationships, Protein Data Bank (PDB) and EM Data Bank, Methods for atomic-resolution structure determination: X-ray crystallography, solution- and solid-state NMR spectroscopy, Single particle Cryo Electron Microscopy, Steady-state and time-resolved fluorescence spectroscopy, FRET.

Unit-IV

DNA and RNA structures: DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction. Structure of Sugars and lipids Structural dynamics: Dynamics of Protein-RNA complexes; Structure and organization of genomes. Simulations: Protein functional dynamics, Protein dynamics studies by MD simulations; Protein dynamics studies by biophysical techniques.

Text Books/References:

1. Biophysical Chemistry vol I, II and III by Charles R. Canter and Paul R. Shimmel.
2. Structure and Mechanism in Protein Science by Alan Fersht.
3. Proteins: Structures and Molecular Properties, by Thomas E. Creighton.
4. Introduction to Protein Structure by Branden and Tooze, Garland Science; 2nd edition 1999.
5. Principles of nucleic acid structure, by Stephen Neidle.

6. RNA Sequence, Structure, and Function: Computational and Bioinformatic Methods by Walter L. Ruzzo, Jan Gorodkin, Springer 2014. 67
7. Crystallography made crystal clear by Gale Rhodes.
8. NMR of Proteins and Nucleic Acids by Kurt Wüthrich.
9. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.

PTC-307	BIOPROCESS ENGINEERING (B. Tech. Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor test**	**Major test**	**Total**	**Time**
2	**-**	**-**	**2**	**25**	**75**	**100**	**3Hrs.**
Purpose	**To introduce the basics of Bioprocess Engineering to the students for applications in Biotechnology**						
Course Outcomes							
CO1	**Introduce the fundamentals of Bioprocess Engineering.**						
CO 2	**To make the students aware of the importance of formulation of culture media and sterilization of process fluids**						
CO 3	**To introduce the concept of configuration and different types of bioreactors**						
CO 4	**To make aware of the applications of Bioprocess Engineering to non- conventional Biological Systems**						

UNIT-I

1. **Introduction to Bioprocess Engineering**. History and Scope of Bioprocess Engineering. Basic concepts and approaches used in Bioprocess Engineering. Microbial growth Kinetics. Bioprocesses: Regulatory Constraints. Steps in Bioprocess development. Major products of biological processing.
2. **Basics of Bioprocess Engineering**. Introduction to Heat Transfer, Mass Transfer and Diffusion Concepts. Material and Energy Balances in a macroscopic view point. Variables, dimensions and units. Dimensionally Homogenous and non-homogenous equations. Standard conditions and ideal gases.

UNITII

3. **Formulation of Fermentation Media**. Principles of microbial nutrition. Formulation of culture media. Factors influencing the choice of various carbon and nitrogen sources. Growth factors and precursors in fermentation media. Rheology of fermentation fluids. Antifoaming and antifoam agents.
4. **Sterilization of Process fluids**. Kinetics of thermal death of cells and spores. Design of batch and thermal sterilization. Sterilization of air and filter design. Radiation and chemical sterilization.

UNIT III

5. **Choosing the Cultivation Method.** Introduction to various kinds of bioreactors. Immobilized cell systems. Solid-state Fermentations and its applications. Various approaches to scale-up including regime analysis and scale- down.

UNIT IV

6. **Applications of Bioprocess Engineering to non-conventional Biological Systems**. Bioprocess considerations in using animal and plant cell cultures. Use of Genetically Engineered Microorganisms in Bioprocess development.

Text Books-

1. Shuler, M. L. and Kargi, F. 2002. Bioprocess Engineering-Basic Concepts. Prentice Hall India, NewDelhi.
2. Doran, P. M. 2013. Bioprocess Engineering Principles.Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology-Theory and Practice. The Energy and Resources Institute, NewDelhi/

Reference Books-

1. Ward, O.P. 1991. Bioprocessing. NewYork
2. Nostrand, R. V., Belter, P.A., Cussler, E. L. and Hu, W. S. 1988. Bioseparations- Downstream Processing forBiotechnology.
3. Lydersen, K. B., D'elia, N. A. and Nelson, K. L. 1994. Bioprocess Engineering: Systems, Equipments and Facilities. John Wiley and Sons, NewYork.

PTC - 309	**Bioinformatics & Computational Biology (B.Tech. Biotechnology Semester V)**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**-**	**2**	**75**	**25**	**100**	**3 Hrs**
Purpose	This course is beneficial for students to understand the principles of analyzing biological data, building models and testing hypotheses using computer science algorithms. It will also introduce information technology practices in the field of biotechnology.						
Course Outcomes							
CO 1	Knowledge about basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases						
CO 2	Student will learn about the foundation of sequence alignment techniques.						
CO 3	Student will learn about the foundation for how to find evolutionary connections.						
CO 4	Knowledge about analyzing mRNA expression data and gene annotations.						

Unit 1

General Introduction: To study bioinformatics and its applications. Biological databases and tools: Nucleotide sequence databases, Protein sequence, structural and functional databases.

Unit 2

Database searching: BLAST and its types, Entrez. Pairwise Sequence alignment: Pairwise alignment, Dynamic programming, Scoring Matrices, Gaps. Multiple sequence alignment.

Unit 3

Phylogenetic analysis: Introduction, Types of Phylogenetic Trees, Methods and Applications. Genome informatics: Genome sequencing technologies and analysis methods; transcription factor regulation and motif finding.

Unit 4

Computational Epigenetic: Epigenetic and its role in transcription regulation, development, and diseases. Molecular modeling (Homology and *Ab initio*) and validation, Docking, Molecular dynamics.

Text Books/References:

1. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0- 470-08585-1.

2. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN: 978-0-87893-309-9.

3. Essential Bioinformatics, Jin Xiong, Cambridge University Press; 1st edition 2006.

4. Bioinformatics: methods and applications, S. C. Rastogi, PHI learning; 4th edition, 2013.

5. The Dictionary of Genomics, Transcriptomics and Proteomics, Günter Kahl, Willey VCH, 2015.

Note: The Examiner will be given the question paper template and will have to set the

question paper according to the template provided along with the syllabus.

PTC-311	Bioinformatics and Computational Biology Lab (B.Tech. Biotechnology Semester -V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Practical**	**Total**	**Time**
-	**-**	**4**	**2**	**40**	**60**	**100**	**3 Hrs**
Purpose	To learn the practical aspects of Bioinformatics and Computational Biology						
Course Outcomes							
CO1	Students will be able to learn basic tools in Bioinformatics.						
CO2	Student will build the foundation of sequence alignment techniques.						
CO3	Students will learn about Multiple Sequences alignment methods.						
CO4	Students will learn how to find evolutionary connections.						

LABORATORY EXPERIMENTS

1. Finding patterns in genomes.
2. Implementation of motif finding algorithms.
3. Basic machine learning using WEKA tool.
4. Accessing databases from NCBI.
5. Extracting protein and nucleotide sequences from NCBI.
6. Database Search Tools.
7. Similarity search using BLAST.
8. Pairwise sequence alignment.
9. Multiple sequence alignment.
10. Conserved domain analysis.
11. Construction of Phylogenetic trees.

Text Books/References:

1. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0- 470-08585-1.

2. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN: 978-0-87893-309-9.

3. Essential Bioinformatics, Jin Xiong, Cambridge University Press; 1st edition 2006.

4. Bioinformatics: methods and applications, S. C. Rastogi, PHI learning; 4th edition, 2013.

5. The Dictionary of Genomics, Transcriptomics and Proteomics, Günter Kahl, Willey VCH, 2015.

PTC-313	Biophysical and Bioanalytical Techniques Lab (B.Tech. Biotechnology) Semester-V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**3**	**1.5**	**60**	**40**	**100**	**3 hrs**
Purpose	**To acclimatize students about different bio analytical techniques.**						
Course Outcomes							
CO1	Students will learn about working of spectrophotometer.						
CO2	Students will be able to learn about technique of chromatography.						
CO3	Students will be able to learn about technique of electrophoresis.						
CO4	Students will be able to estimate DNA and RNA in any sample.						

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LABORATORY EXPERIMENTS

1. To verify the validity of Beer-Lambert's law and determine the molar extinction coefficient of NADH/NAD
2. Separation of amino acids/ sugars by paper chromatography.
3. Extraction and estimation of total lipid content in a given sample of oil seed.
4. Partial purification of an enzyme by ammonium sulphate fractionation,
5. Native gel electrophoresis of proteins.
6. To demonstrate the working of HPLC.
7. Quantitative determination of DNA and RNA by spectrophotometric method.

Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw

PTC-315	Metabolic Engineering Lab (B.Tech. Biotechnology) Semester- V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	**0**	**3**	**1.5**	**60**	**40**	**100**	**3 hrs**
Purpose	The course will provide an overview of the basic concepts and experimental techniques used in metabolic engineering						
Course Outcomes							
CO1	Students will learn about applications in production of useful compounds of industrial importance						
CO2	Students will learn about successful engineering strategies used for the production of commercially important primary metabolites						
CO3	Students will learn about successful engineering strategies used for the production of commercially important secondary metabolites						
CO4	Students will learn about successful engineering strategies used for the production of recombinant proteins.						

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LABORATORY EXPERIMENTS

1. Develop engineering strategies to boost production of industrially relevant compound in *E. coli.*
2. Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.
3. Demonstration of feed-back regulation and product inhibition
4. Development of a flux model and correlation of the model with experimental data

Text Books/References:

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit.
3. The Metabolic Pathway Engineering Handbook by Christina D. Smolke.
4. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark.

PTE-301	GOOD MANUFACTURING AND LAB PRACTICES (B. Tech. Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Major Test**	**Total**	**Time**
2	**1**	**-**	**3**	**25**	**75**	**100**	**3 Hrs.**
Purpose	Basic understanding of the regulatory requirement of Good manufacturing practices and Good laboratory practices.						
Course Outcomes							
CO1	To familiarize the students with basics of GMP and GLP.						
CO 2	To gain knowledge of concepts of design of experiments and quality by design in pharmaceutical industries.						
CO 3	To understand the objectives of International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use.						
CO 4	To explore the principles of regulation of clinical and pre-clinical studies.						

UNIT-I

1. Introduction to Good Manufacturing and Laboratory Practice, Requirement of GLP and GMP compliance for regulatory approval, Ethics in manufacturing and control.

UNIT-II

2. Introduction to the concept of Design of Experiment (DOE) Principles of quality by design (QBD). Application of QBD principles in Biotech product development. Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development.

UNIT-III

3. Introduction to ICH guidelines and their usage. National and international regulatory authorities and their function, Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process.

UNIT-IV

4. Regulation of Clinical and Preclinical Studies, Good Manufacturing Practices, Formulation Production Management, Authorization and marketing of drugs. Computer simulation on process design.

Text Books/References:

1. cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Createspace Independent Publishing Platform, April 2016.
2. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.
3. Sarwar Beg and MdSaquibHasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.
4. Ron S. Kenett, ShelemyahuZacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014.
5. N Politis S, Colombo P, Colombo G, M RekkasD.Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm. 2017 Jun;43(6):889-901. doi: 10.1080/03639045.2017.1291672.

PTE-303	GENOME EDITING (B. Tech. Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Major Test**	**Total**	**Time**
2	**1**	**-**	**3**	**25**	**75**	**100**	**3 Hrs.**
Purpose	Basic understanding of the genetic engineering tools used in gene editing and its varied applications in biotechnological research.						
Course Outcomes							
CO1	**To familiarize the students with basics of molecular biology.**						
CO 2	**To gain knowledge of concepts of CRISPR technology.**						
CO 3	**To understand the applications of genome editing techniques.**						
CO 4	**To explore the ethical aspects of genome editing.**						

UNIT-I

1. Introduction to genetic engineering; limitations of genetic engineering; double stranded DNA breaks and repair; homologous and non-homologous recombination; knock-ins and knock-outs.
2. Genome engineering using Zinc Finger Nuclease (ZFN) Technology; Transcription activator-like effector nuclease (TALEN) Technology.

UNIT-II

3. Clustered regularly interspaced short palindromic repeats (CRISPR)/Cas9 technology: target identification, gRNA design, donor design, screening and validation.

UNIT-III

4. Applications in treating human diseases: Human cell engineering-Thalassemia, SCID, Hemophilia, etc; Disease modeling-Cancer, iPSc and animal models.

UNIT-IV

5. Engineered immune cells for cancer therapy; Personalized therapy; Challenges: safety and specificity; Ethical concerns: Germ line gene editing.

Texts/ Reference Books

1. Harber , J. E., Genome Stability: DNA Repair and Recombination , Garland Science, 2013.

2. Yamamoto, T. Targeted Genome Editing Using Site-Specific Nucleases, Springer, 2015.

3. Zlatanova, J. and Holde, K. van, Molecular Biology: Structure and Dynamics of Genomes and Proteomes. Garland Science, 2015.

4. Yamamoto, T.(Ed.), Targeted Genome Editing Using Site-Specific Nucleases: ZFNs, TALENs, and the CRISPR/Cas9 System , Springer 2015.

References:

1. Barrangou , R. and Oost, J. van der, CRISPR-Cas Systems: RNA-mediated Adaptive Immunity in Bacteria and Archaea , Springer, 2013.

2. Addgene, CRISPR 101:A Desktop Resource , January 2016

3. Alberts , B. , Johnson , A., Lewis , J., Morgan, D., Raff, M., Roberts, K.and Walter, P., Molecular Biology of the Cell, 6th Edn., Garland Science, 2014.

PTE-305	**Biochemical and Enzyme Technology (B.Tech Biotechnology Semester V)**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To provide a solid foundation for understanding Biochemical and Enzyme Technology.						
	Course Outcomes **After completion of course, the learner will be able**						
CO 1	To enlist the relationship between domains and functions of proteins.						
CO 2	To explain the advantages of enzyme based production processes.						
CO 3	To write the steps involved in downstream processing of enzymes.						
CO 4	To explain the bioinformatics tools used for structure prediction of enzymes.						

Unit-I

Building Block of Proteins: Physiochemical Properties of Proteins, common plant Protein Sources, Protein Databases. Dissociation constant, Isoelectric point, protein denaturation and renaturation. Structural Organization: Structural organization of Protein (different models), Dynamics of Domain and Motifs: Motifs, domains, Models, Functional relationship between domains and function of proteins, super secondary structures of proteins Classification of proteins based on the structures like Zn finger, lucine zipper proteins etc

Unit-II

Introduction to enzyme Technology: What are Biocatalysts? Bio- and Chemo catalysts – Similarities and Differences, Goals and Potential of Biotechnological Production Processes, The Use of Isolated or Intracellular Enzymes as Biocatalysts, Advantages and Disadvantages of Enzyme-Based Production Processes, Goals and Essential System Properties for New or Improved Enzyme Processes, Essential System Properties for Rational Design of an Enzyme Process , Current Use and Potential of Enzyme Technology.

Unit-III

Enzyme Production and Purification: Enzyme Sources, Animal and Plant Tissues, Wild-Type Microorganisms, Recombinant Microorganisms Improving Enzyme Yield, Processes that Influence the

Enzyme Yield, Increasing the Yield of Periplasmic and Extracellular Enzymes Penicillin Amidase, Lipase, Downstream Processing of Enzymes, Static and Dynamic Properties of Chromatographic Adsorbents that Must Be Known for a Rational Design of Chromatographic Protein Purification.

Unit-IV

Advance techniques in enzyme research: Forward Enzyme Screening Approach, Reverse Enzyme Screening Approach, Enzyme Engineering, Enzyme Structure and Function Determination, enzyme stabilization

Text Books/References:

1. Biocatalysts and Enzyme Technology by Klaus Buchholz, Volker Kasche, and Uwe T. Bornscheuer (2012) 2nd edition; Wiley-Blackwell
2. Biotechnology of Microbial Enzymes editor: Goutam Brahmachari (2017) Academic press
3. Green Biocatalysis Edited by Ramesh N. Patel (2016) Wiley & sons
4. Advances in Enzyme Biotechnology, edited by Pratyoosh Shukla& Brett I. Pletschke (2013) Springer

PTE-307	Bioreactor Analysis and Design (B.Tech Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To familiarize the students about the bioreactor and its internal function with microbial growth kinetics						
	Course Outcomes						
CO 1	To understand the basic concept of bioreactor						
CO 2	To understand the mass transfer of different reactor						
CO 3	To understand the solid state fermentation						
CO 4	To understand the optimization process						

Unit- I

Basic concept of bioreactors: Basic objective of bioreactor design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Validation of bioreactor.

Unit-II

Different Types of reactor: Batch Reactor, Fed batch reactor, continuous stirred tank reactor (CSTR), Fluidized bed reactor, air lift bioreactor, and numerical aspect of all types of reactors.

Unit-III

Cultivation Methods: Immobilized cell systems. Solid-state Fermentations and its applications. Rheology of fermentation fluids. Various approaches to scale-up the process

Unit-IV

Process Parameters: Heterogeneous reaction in process. Heat and mass transfer. Non ideal bioreactor- Design and Analysis. Different optimization parameters in a process.

Text Books

1. Shuler, M. L. and Kargi, F. 2002. Bioprocess Engineering-Basic Concepts. Prentice Hall India, New Delhi.
2. Doran, P. M. 2013. Bioprocess Engineering Principles. Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology- Theory and Practice. The Energy and Resources Institute, New Delhi.

OTS-301	BIOMATERIAL TECHNOLOGY						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hrs.**
Program Objective (PO)	To enable students to understand the role of gene therapy in treatment of severe diseases.						
Course Outcomes (CO)							
CO1	Students will learn about basics of Biomaterials, need of biomaterials, types of biomaterials, techniques for characterization of biomaterialas and their potential applications						
CO2	Students will learn about biomaterial degradation, cell interaction with biomaterial and process to improve biocompatibility						
CO3	Students will have knowledge about Biomaterial implantation, imuune and infalammatory response to biomaterial, tests for hemocompatibility						
CO4	Students will have learn about the risk of Infection, tumorigenesis and calcification Associated with biomaterials						

UNIT I

Introduction to biomaterials: Definition of biomaterials, History and current status of the field, Types of biomaterials, Important properties of biomaterials.

UNIT II

Biomaterial degradation in Biological environment; Biodegadable materials: Ceramics and polymers; Processing to improve biocompatibility: sterilization. Cell interactions with biomaterials: Techniques Assays to determine effects of cell-material interactions: Cytotoxicity assays, DNA and RNA assays and Protein production assays- Immunostaining.

UNIT III

Biomaterial implantation and Immune response to biomaterials. Undesired immune responses to biomaterials:Clinical signs of acute inflammation against biomaterials. In vitro assays for inflammatory response. Biomaterials and thrombosis: Tests for hemocompatability.

UNIT IV

Infection, tumorigenesis and calcification of biomaterials. Overview of potential problems with biomaterial implantation, steps to infection, techniques for infection experiments. Biomaterial related tumorigenesis, In vitro and in vivo models for tumorigenesis experiments, pathologic calcification of biomaterials and techniques for pathologic calcification experiments.

Text/References:

1. Temenoff, I.S. and Mikos, A.G. Biomaterials: The Intersection of Biology and Material Science. Pearson Education, India. 2009 Indian ed.

2. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2nd Edition, 2001.

3. J B Park, Biomaterials - Science and Engineering, Plenum Press, 1984.

4. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

5. C.P.Sharma & M.Szycher, Blood compatible materials and devices, Technomic Publishing Co. Ltd., 1991.

6. Piskin and A S Hoffmann, Polymeric Biomaterials (Eds), Martinus Nijhoff Publishers. (Dordrecht. 1986)

7. Eugene D. Goldbera, Biomedical Ploymers. 8. Specific journals and published references.

OTS-303	Internet of Things (B.Tech Biotechnology) Semester- V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Purpose	**To familiarize the students with the new development in Internet of Things**						
Course Outcomes							
CO1	Understand what IoT technologies are used for today, and what is required in certain scenarios.						
CO2	Understand the types of technologies that are available and in use today and can be utilized to implement IoT solutions						
CO3	Understand the type of protocols and challenges for designing IoT systems.						
CO4	Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications. Understand operating system requirements of IOT.						

Unit I

Introduction to IoT: Defining IoT, Characteristics of IoT, Functional blocks of IoT, Physical and logical design of IoT, Smart cities and IoT revolution, Difference between IoT and M2M, M2M And peer networking concepts Ipv4 and IPV6, Software Defined Networks SDN.

Unit II

IoT design methodology, case study on IoT system for weather monitoring. IoT system Management, Developing IoT applications through embedded system platform: Introduction to sensors, IoT physical devices and endpoints, Raspberry pi, Raspberry pi interfaces, Arduino, arduino interfaces.

Unit III

Protocols for IoT- messaging protocols, transport protocols, Ipv4, Ipv6, URI, Cloud for IoT: IoT with cloud, challenges, introduction to fog computing, cloud computing, Challenges in IoT: Design challenges, development challenges, security and legal considerations.

Unit IV

Logic design using Python: Introduction to python, data types, data structures, control flow, functions, modules, file handling and classes., implementing IotT concepts with python, Applications of IoT, Connected cars IoT Transportation, Smart Grid and Healthcare sectors using IoT,

Text Books/References:

1) A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, University press, 2014.

2) S.K.Vasudevan, A.S.Nagarajan, “Internet of Things”, Wiley, 2019.

3) CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.

Samuel Greenguard, “Internet of things”, MIT Press, 2015.

OTS-305	Image Processing (B.Tech. Biotechnology) Semester- V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Course Outcomes							
CO1	To review image processing techniques for computer vision.						
CO2	To understand three-dimensional image analysis techniques.						
CO3	To understand shape and region analysis.						
CO4	To study some applications of computer vision algorithms.						

UNIT-1

IMAGE PROCESSING FUNDAMENTALS

Review of image processing, Filtering types, thresholding techniques, edge detection techniques, line and point detection, Region descriptors, and mathematical morphology.

UNIT-2

Image Enhancement

Basics of intensity Transformations, Histogram processing, Spatial Domain filtering, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering, Frequency Domain Filtering, Sampling and Fourier Transform of sampled functions, 2-D Sampling, Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

UNIT-3

Shapes and Regions

Binary shape analysis, connectedness, object labelling and counting, skeletons and thinning, active contours, shape modals and shape recognition, boundary descriptors.

Image Compression: Fundamentals, Image Compression models, Error Free Compression – Huffman Coding, Arithmetic Coding, LZW Coding, Lossy Compression – Block transformcoding

UNIT-4

Applications

Photo album, Face detection, face recognition, Surveillance, In vehicle vision system: locating roadway, road markings, identifying road signs, locating pedestrians.

Text Books/Reference Books

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education,
2. R. Szeliski, “Computer vision: Algorithms & Applications”, Springer, 2011

OTS-307	3D Printing and Design (B.Tech. Biotechnology) Semester- V						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Course Outcomes							
CO1	Introduction of 3D Printing followed by CAD						
CO2	To Understand different Manufacturing Techniques						
CO3	To understand use of different materials for 3D Printing						
CO4	To study some applications of 3 D Printing						

UNIT-1

3D Printing: Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications. CAD Data formats, Data translation, Data loss, STL format.

UNIT-2

Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools

UNIT-3

Materials: Polymers, Metals, Non-Metals, Ceramics. Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials

UNIT-4

Post Processing: Requirement and Techniques

Process Equipment- Design and process parameters Governing Bonding Mechanism Common faults and troubleshooting .Process Design

Text Books/Reference Books

1. Sabrie Soloman, “3D Printing and Design”, Khanna Publishing House, Delhi.
2. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
3. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.

ATU-301	Indian Constitution (B.Tech Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**-**	**-**	**2**	**75**	**25**	**100**	**3 hrs**
Purpose	To understand the basic concepts of Indian Constitution						
	Course Outcomes **After completion of course the students will be able**						
CO 1	To explain the basic structure of Indian Constitution						
CO 2	To understand the structure of Indian Union						
CO 3	To write down roles and powers of Governer						
CO 4	To explain the election process under Indian Constitution.						

Unit 1

The Constitution - Introduction ● The History of the Making of the Indian Constitution ● Preamble and the Basic Structure, and its interpretation ● Fundamental Rights and Duties and their interpretation ● State Policy Principles

Unit 2

Union Government ● Structure of the Indian Union ● President – Role and Power ● Prime Minister and Council of Ministers ● Lok Sabha and Rajya Sabha

Unit 3

State Government ● Governor – Role and Power ● Chief Minister and Council of Ministers ● State Secretariat

Unit 4

Local Administration ● District Administration ● Municipal Corporation ● Zila Panchayat Election Commission a. Role and Functioning b. Chief Election Commissioner c. State Election Commission

Suggested Learning Resources:

1. Ethics and Politics of the Indian Constitution Rajeev Bhargava Oxford University Press, New Delhi, 2008

2 The Constitution of India B.L. Fadia Sahitya Bhawan; New edition (2017)

3 Introduction to the Constitution of India DD Basu Lexis Nexis; Twenty-Third 2018 edition

Suggested Software/Learning Websites: 1. https://www.constitution.org/cons/india/const.html
2. http://www.legislative.gov.in/constitution-of-india
3. https://www.sci.gov.in/constitution
4. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-ofindia/

ATU-903	Essence of Indian Traditional Knowledge (B.Tech Biotechnology Semester V)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	-	-	-	**100**	-	**100**	**3 hrs**
Purpose	To impart basic principles of thought process and reasoning						
	Course Outcomes						
CO 1	The students will be able to understand , connect up and explain basics of Indian traditional knowledge in modern scientific perspective						

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
- Fritzof Capra, *Tao of Physics*
- Fritzof Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

PTC-302	Downstream Processing and bioseparation Engineering (B.Tech. Biotechnology) Semester-VI						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**-**	**4**	**75**	**25**	**100**	**3 hrs**
Purpose	**To familiarize the students with the Downstream Processing**						
Course Outcomes							
CO1	Students will become familiar to upstream and downstream processing						
CO2	Students known about cell disintegration and primary methods of separation in DSP						
CO3	Students will develop knowledge to Emerging separation techniques						
CO4	Students will develop focus on different examples of DSP						

UNIT –I

Introduction: History and scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and downstream processing.Physicochemical basis of bio separation

UNIT – II

Cell disintegration: Separation of particulate by centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction and sorption.

Purification methods: Precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

UNIT – III

Emerging separation techniques: Immobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation. Separation of intracellular, extracellular, heat and photosensitive materials.

UNIT – IV

Downstream processes and effluent treatment: Applications of Unit Operations in Downstream with special reference to membrane separations & extractive fermentation, anaerobic and aerobic treatment of effluents. Typical examples effluent disposal in process industries.

Text and Reference books

1. Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.

2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamonpress.

3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York

4. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

PTC-304	SYNTHETIC AND SYSTEMS BIOLOGY (B. Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Minor Test**	**Major Test**	**Total**	**Time**	**Credit**
2	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**	**3**
Purpose	This course introduces students to the rapidly evolving field of Systems & synthetic biology.						
Course Outcomes							
CO1	**To familiarize the students with basics of synthetic and systems biology.**						
CO 2	**To gain knowledge of tools used in synthetic biology.**						
CO 3	**To understand the applications of mathematical modeling in systems biology.**						
CO 4	**To explore the applications of synthetic and systems biology.**						

UNIT-I

Introduction to Synthetic biology & Systems biology Introduction to synthetic biology. Background of Gene Regulatory Mechanisms (Gene Parts- Gene Structure, Promoters, Terminators, Enhancers, Inducers, Repressors, Transcription Factors, Co-factors, transcriptional and post-transcriptional regulation, post-translational modifications). Genetic Engineering and Genome Editing Various Omics & role in systems biology - genomics, proteomics, transcriptomics, metabolomics

UNIT-II

Introduction to graph Theory: Basic; why graphs? types of graphs; computational representation of graph; graph representation of biological networks; common challenges and software tools.

UNIT-III

Elements of synthetic biology - Tools, circuits, BioBricks Gene shuffling for large scale pathway assembly and engineering; Choices for microbial hosts for industrial applications– bacteria, yeast, insect. Gene sequencing – Pyrosequencing, Nanopore sequencing. Bacterial circuits: feedback, feed-forward, toggle switch, signal propagators and band filter, synchronized oscillators. Introduction to Bio Bricks & its applications. Microarrays & systems biology - a basic introduction

UNIT-IV

Commercial Applications Biomedicine, Biomaterials, Biofuels and Bioremediation; Production of artemisinin as case study. Building the new bio-economy. Introduction to Biofoundries & circuits. Role of automation and robotics in biofactories; Green chemistry - use of plants for engineering biologics & small molecules. Global events & competitions- iGEM, synbiobeta. Regulations & ethics Safety & bioethics, legal & IP elements involved in synthetic biology applications for human, animals and plants.

Text Books/References

1. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC (2006).

2. Eric Davidson, The Regulatory Genome: Gene Regulatory Networks In Development And Evolution, Academic Press (2006).

3. Hamid Bolouri, Computational Modeling of Gene Regulatory Networks - A Primer, Imperial College Press (1st edition) (2008).

4. Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pte Ltd

5. Singh, V and P.K. Dhar. (2015). Systems and Synthetic Biology. Springer publishing, Netherlands

6. Karthik Raman (2012) An Introduction to Computational Systems Biology ; Chapman & Hall/CRC

PTC-306	Animal and Plant Biotechnology (B.Tech Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To familiarize the students about Genetic alteration for superior breed development and micro-propagation for large scale metabolite synthesis						
	Course Outcomes						
CO 1	To understand the Basic concepts of animal cell culture.						
CO 2	To understand the theoretical aspects of Transgenic animals Methodology						
CO 3	To understand Plant cell tissue culture history and present perspectives						
CO 4	To understand genetic modification to develop new resistant varieties better suited to environment conditions						

Unit- I

Introduction and Scope of Animal Biotechnology: History and scope of animal cell culture; Cell culture media and reagents, culture of cells, tissues and organs, establishment of cell culture, continuous cell lines, suspension cultures.

Unit-II

Transgenic animals Methodology: Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer.

Unit-III

Tissue Culture: Micropropagation,application and future prospects,Different types of culture-seed,embryo,callus, organ,cell and protoplast.Somaclonal variations, Somatic cell hybrids,Haploid production,Germplasm storage and conservation.

Unit-IV

Transgenics and crop improvement: Development of plants to disease,biotic stress and insect and pest. Transgenics case studies –implementation, market reach and acceptance.Consequences of transgenics on social well being and environmental concern

Text Books

1. Principles of Gene Manipulations 6th edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles and Applications of recombinant DNA 2nd Edition. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Animal Cell Biotechnology : Spier, R.E. and Griffiths J.B. (1988) Academic press.
4. Introduction to Plant Biotechnology 2nd edition. Chawla, H.S. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

5. Molecular Biotechnology: Principles and Applications of recombinant DNA. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
6. Plant Tissue culture: Theory and Practice. Bhojwani, S.S. and. Razdan M.K (1996) Elsevier Science, Netherlands

PTC-308	Data Science in Genome Technology (B.Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**-**	**3**	**75**	**25**	**100**	**3 Hrs**
Purpose	The course will introduce the next-generation sequencing platform used to quantify DNA, RNA, and epigenetic patterns. Student will get an introduction to the key concepts in computing and data science that will help to understand how data from next-generation sequencing experiments are generated and analyzed.						
Course Outcomes							
CO 1	Knowledge regarding the basic biology of modern genomics.						
CO 2	Building the foundation of Measurement Technologies used in Genome Technology.						
CO 3	Students will learn the foundation for computational biology software's.						
CO 4	Knowledge about analyzing data with use of Statistical tools.						

Unit 1

Introduction of Molecular biology: - The genome, Writing a DNA sequence, Central dogma, Transcription, Translation, and DNA structure and modifications, Human Genome Project.

Unit 2

Measurement Technology: - Polymerase chain reaction, Different Types of PCR, Next Generation Sequencing, brief introduction to different types of NGS and applications of sequencing.

Unit 3

Computing Technology: -Basic topics in computing technology, Computer science, algorithms, memory and data structures, efficiency, software engineering, and computational biology software etc.

Unit 4

Data Science Technology: - Handling the data produced during the sequencing process. reproducibility, analysis, statistics, question types, the central dogma of inference, analysis code, testing, prediction, variation, experimental design, confounding, power, sample size, correlation, causation, and degrees of freedom.

Text/Reference Books:-

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.

2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.

PTE-302	Machine Learning (B.Tech Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To familiarize the students about different aspects of Machine Learning						
	Course Outcomes						
CO 1	To introduce students to the basic concepts and techniques of Machine Learning.						
CO 2	To have a thorough understanding of the Supervised and Unsupervised learning techniques						
CO 3	To study the various probabilities based learning techniques.						
CO 4	To understand graphical models of machine learning algorithms.						

Unit-I

Introduction: Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

Unit-II

Linear Models: Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

Unit-III

Tree and Probabilistic Models: Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

Unit-IV

Dimensionality Reduction, Evolutionary and Graphic Models: Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using

Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process. Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

Text Books:

1. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.
3. Jeeva Jose, - Introduction to Machine Learning using Python‖, First Edition, Khanna Publishing House, 2019.

References:

1. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
2. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014.
3. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series) ‖, Third Edition, MIT Press, 2014.
4. Rajiv Chopra, - Machine Learning ‖, Khanna Book Publishing Co. 2019.

PTE-304	Waste Management & Upcycling (B.Tech. Biotechnology) Semester-VI						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**0**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	• To familiarize the students fundamental aspects of types of waste and its management. • To disseminate knowledge on various waste management technologies. • To provide knowledge on how waste can be converted to wealth in a sustainable way. • To enable students to think innovative way to develop concepts in waste management.						
Course Outcomes							
CO1	The students shall get an adequate knowledge on waste and its sustainable management.						
CO2	Students should get enough knowledge on safety guidelines of waste management.						
CO3	Students in groups shall develop concepts in managing waste of their institutions.						
CO4	Students should get experiential learning with a waste management company in the vicinity.						

UNIT –I

Waste management: The definition of waste, and its classification in the context of EU legislation, policy including the planning and permitting regime for the delivery of waste management solutions.

UNIT – II

Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge of industrial emissions.

Technologies for Waste treatment technologies: waste incineration and energy from waste, pyrolysis and gasification , managing biomedical waste,

UNIT – III

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment. The management of landfill leachate. Recovery technologies to deliver added value products. Innovative technologies for sustainable waste management.

UNIT – IV

Interface of waste and resource management; carbon foot-printing. Waster Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise,

Case study in each area**.**

Text and Reference books

1. O.P. Gupta, " Elements of Solid & Hazardous Waste Management ", Khanna Publishing House, New Delhi, 2019.
2. George Tchobanoglous et.al., " Integrated Solid Waste Management ", McGraw-Hill Publishers, 1993.
3. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, " Waste Management ", Springer, 1994.
4. Environmental Biotechnology. Jogland, S.N. (1995) Himalaya Publishing House, New Delhi.
5.Environmental Biotechnology: Bhattacharya and Banerjee (2007) Oxford University Press.
6. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) 1985 Elsevier Sciences.
7. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.

PTE-306	Stem Cell Technology (B.Tech. Biotechnology) Semester- VI						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**0**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	The objective of this course is to enable students to understand the principles of stem cells, their isolation and maintenance and their application in different therapies						
Course Outcomes							
CO1	Students will be able to differentiate among the different types of stem cells						
CO2	Students will be able to explain the concept of stem cell cloning						
CO3	Students will be able to compare the isolation and maintenance methods for different type of stem cells						
CO4	Students will be able to recognize the applications of stem cells in different diseases						

Unit I

Introduction

Basic concepts and properties of Stem cells, Totipotency and Pluripotency, Types of stem cells: Embryonic stem cells, Germinal stem cells, Adult stem cells, Tumor stem cells.

Unit II

Molecular Cell Biology and Cloning

Cell cycle regulation in stem cells. Stem cell niches

Therapeutic and reproductive cloning, Nuclear Transfer method, Application of nuclear transfer derived embryonic stem cells.

Unit III

Stem Cells maintenance and transplant

Sources of stem cells; Cell types for transplantation: Bone marrow, Peripheral stem cells, cord blood stem cells

General methods of Isolation, Identification, Characterization and maintenance of different stem cells: Embryonic stem (ES) cells, Hematopoietic Stem Cells (HSC), Mesenchymal stem cells

Unit IV

Stem cells and Therapy

Organ factories, drug discovery and development, Medical applications in Leukemia, Immune deficiencies, diabetes, liver diseases, cardiovascular diseases,

Recommended Books

Text Books

1. Anthony Atala, Robert Lanza. Essentials of Stem Cell Biology. Netherlands: Elsevier/Academic Press, 2014.
2. Atala A & Lanza R, Stem Cells Handbook. Netherlands: Springer New York, 2013.
3. Satish Totey and Kaushik D. Deb. Stem Cell Technologies: Basics and Applications (McGraw-Hill, 2010).

Reference Books

1. Robert A. Meyers Stem Cells: From Biology to Therapy (Current Topics from the Encyclopedia of Molecular Cell Biology and Molecular Medicine), 2013

PTE-308	Nano-biotechnology (B.Tech Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**1**	**0**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To familiarize the students about different aspects of Nanobiotechnology.						
	Course Outcomes						
CO 1	To understand the basic concept of Nano biotechnology and different characterization techniques						
CO 2	To understand about basics of BioMEMS and different advancements in sensors						
CO 3	Students will learn about different types of nanomaterials						
CO 4	Students will have clear idea about different applications of nanotechnology in life science						

Unit-I

Introduction to Nanotechnology: Definition of Nano biotechnology, A brief history of the Super small, Bottom-up versus top-down, discussion on nanofabrication, nanolithography, Nano biotechnology, Structure property relations in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, Biomolecule-surface interactions, DNA microarrays.

Unit-II

BioMEMS: Introduction and overview, biosignal transduction mechanisms. Electromagnetic transducers: basic sensing mechanisms, basic actuating mechanisms. Mechanical transducers: basic sensing mechanisms, basic actuating mechanisms. Chemical transducers: basic sensing mechanism, basic actuating mechanism, ultimate limits of fabrication and measurement.

Unit-III

Nanomaterials: Buckyballs and buckytubes manufacturing, diagnostics and sensors, nanobiosensors, Carriers, Dendrimers as nanoparticle, nanoshells, quantum dot nanocrystals, nanotubes and hybrid biological/ inorganic devices.

Unit-IV

Applications of nanotechnology in the life science: Leading applications of nanobiotechnology: drug delivery. nanorobots. Benefits of nano drug delivery. Drug delivery using nanocrystals, drug discovery using Resonance Light Scattering (RLS) technology, rapid ex-vivo diagnostics, nanosensors as diagnostics agents

References Books :

1. Unbounding the future by K Eric Drexler, C.Pelerson, G.Pergamit Willaim Marrow and Company, 1993

2. Biological molecules in Nanotechnology By Stephen Lee and Lynn M Savage, 2004

3. Nanotechnology By mark Ratner and Dan Ratner, Prentice Hall, 2005.

OTS-302	ARTIFICIAL INTELLIGENCE (B. Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Minor Test**	**Major Test**	**Total**	**Time**	**Credit**
2	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**	**2**
Purpose	This course will allow gaining expertise in one of the most fascinating areas of Computer Science through a classroom program that covers fascinating and compelling topics related to human intelligence and its applications in industry, defense, healthcare, agriculture, and many other areas						
Course Outcomes							
CO1	**To familiarize the students with basics of Artificial Intelligence.**						
CO 2	**To gain knowledge of tools used in algorithm search and their design.**						
CO 3	**To understand the applications of probability and mathematical modeling in AI.**						
CO 4	**To explore the concept of reinforcement learning and other learning methods in AI.**						

UNIT-I

Introduction: Concept of Artificial Intelligence, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

UNIT-II

Search Algorithms Random search, Search with closed and open list, Depth and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

UNIT-III

Probabilistic Reasoning Probability, conditional probability, Bayes Rule, Bayesian Networks-representation, construction and inference, temporal model, hidden Markov model.

Markov Decision process MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

UNIT-IV

Reinforcement Learning Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active E reinforcement learning- Q learning.

Text/Reference Books

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice Hall

2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill

3. Trivedi, M.C., “A Classical Approach to Artificial Intelligence”, Khanna Publishing House, Delhi. 4. SarojKaushik, “Artificial Intelligence”, Cengage Learning India, 2011

5. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010

OTS-304	Quantum Computing (B.Tech. Biotechnology) Semester-VI						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**-**	**2**	**75**	**25**	**100**	**3hrs**
Purpose	**The objective of this course is to impart the necessary knowledge to the learner so that he/she can develop and implement algorithms and write programs using these algorithms**						
Course Outcomes							
CO1	Explain the working of a Quantum Computing program, its architecture and program model.						
CO2	Develop quantum logic gate circuits.						
CO3	Develop quantum algorithm						
CO4	Program quantum algorithm on major toolkits.						

UNIT-I

Introduction to Quantum Computing: Motivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bra-ket notation. Bloch Sphere representation o Quantum Superposition, Quantum Entanglement

UNIT-II

Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigenvalues and Eigenvectors

UNIT-III

Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere o Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perspective e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc. Programming model for a Quantum Computing Program , Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits

UNIT-IV

Quantum Algorithms: Basic techniques exploited by quantum algorithms., Amplitude amplification , Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks, Major Algorithms o Shor's Algorithm o Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm,

OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM)

Text/Reference Books

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley.
3. IBM Experience: https://quantumexperience,ng,bluemix.net
4. Microsoft Quantum Development Kit https://www.microsoft.com/enus/quantum/development-kit.
5. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/

OTS-306	Cyber Security						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	To gain a broad understanding in order to get predictive ways out related to cyber security.						
Course Outcomes							
CO1	To facilitate the basic knowledge of cyber security.						
CO2	To explore and sort issues related to different types of activities in cyber crime.						
CO3	To get enable to fix the various cyber attacks.						
CO4	To deal with the digital forensics and Legal Perspectives of Cyber crimes .						

Unit-I

Introduction: Introduction and Overview of Cyber Crime, Nature and Scope of Cyber Crime, Types of Cyber Crime: crime against individual, Crime against property, Cyber extortion, Drug trafficking, cyber terrorism.

Unit-II

Cyber Crime Issues: Unauthorized Access to Computers, Viruses and Malicious Code, Internet Hacking and Cracking, Virus and worms, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Password Cracking, Steganography and Key loggers

Unit-III

Introduction to cyber attacks: Passive attacks, active attacks, Cyber crime prevention methods, Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection, Access Control, Hardware protection mechanisms, OS Security

Unit-IV

Digital Forensics: Introduction to Digital Forensics, historical background of digital forensics, Forensic Software and Hardware, need for computer forensics science, special tools and techniques digital forensic life cycle.

Law Perspective: Introduction to the Legal Perspectives of Cybercrimes and Cyber security, Cybercrime and the Legal Landscape around the World, Why Do We Need Cyber laws, The Indian IT Act.

Suggested Books:

1. Nelson Phillips and Enfinger Steuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi, 2009.

2. Robert M Slade," Software Forensics", Tata McGraw - Hill, New Delhi, 2005.
3. Sunit Belapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt. Ltd.

OTS-308	Design Thinking						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Course Outcomes							
CO1	To facilitate the basic knowledge of Design Thinking						
CO2	Students become capable of innovative design thinking						
CO3	Students are able to design & realize prototype and experiments						
CO4	Students will be able to explore the innovation ideas and templates.						

Unit-I

Introduction to Design Thinking: Design Thinking. Preparing Your Mind for Innovation, Empathize Phase: Customer Journey Mapping, Analyze Phase: Idea Generation, Free Brainstorming & Make/Test Phase: Prototype, Experimentation.

Unit-II

Innovation by Design: Design Thinking and Collaboration, Challenges to Innovation, Understanding Users, Arriving at Design Insights, Prototyping for User Feedback, Cause, Crossing the first Pitfall, Trial and Error, User Feedback for Development, New users, New needs to meet, Knowing the Context.

Unit-III

Context, Comprehension, Check and Cause: The Context,The Basic Need, Ingenious Attempt, Further Insights, Working Rig, Concepts Generation, Experiencing the Product, Refinements. Comprehension, Understanding Constraints, Positioning the Product, Exploring Possibilities, More Experiment, Understanding the Technology, At the 2nd Valley of Death, Finishing Touches. Check and Cause, product, Users and the Context, Prototyping, User Needs. Crucial Step Missed.

Unit-IV

Conception, Crafting and Connection: The Conception, Synchronic Studies, One Product, many problems, Concept Clusters, From Idea to Product, Prototyping, Material and Technologies, Collaborative Efforts. Crafting, Recap, Manufacturing Challenge, User Feedback, The Iterative Process. Connection, Seed for Innovation, Pinnacle for Innovation, Innovation Timeline, Innovation Champions, Innovation Domain, Innovation Template, Serial Innovation

Text Books:

1. Innovation By Design by Chakravarthy, BattulaKalyana, and JanakiKrishnamoorthy, Springer India, 2013, ISBN 978-81-322-0901-0

Reference Books

1. Innovation by Design: How Any Organization Can Leverage Design Thinking to Produce Change, Drive New Ideas, and Deliver Meaningful Solutions by Thomas Lockwood, New Page Books, US; 1st edition (28 November 2017), ISBN: 1632651165.
2. Innovation by Design by Gerard Gaynor, Amacom, A Division of American Management Associ135 West 50th Street New York, NY, United States, ISBN:978-0-8144-0696-

PTC-308 L	Data Science in Genome Technology Lab (B.Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Practical**	**Total**	**Time**
-	**-**	**2**	**1**	**40**	**60**	**100**	**3 Hrs**
Purpose	To learn the practical aspects of Data Science in Genome Technology Lab						
Course Outcomes							
CO1	Students will be able to learn basic tools in Genome Technology.						
CO2	Student will build the foundation of Data Science.						
CO3	Students will learn about techniques in molecular Biology.						
CO4	Students will learn about various tools/resources in Statics for genome anaylsis.						

LABORATORY EXPERIMENTS

1. Database Search Tools.
2. Analysis of Protein structures.
3. Identifying various regions around genes using Genome browsers.
4. Browsing genetic variation databases such as dbSNP, ClinVar.
5. Software Analysis of Statistic Functions like Mean, Median mode etc.
6. Calculation of Variation and Standard Deviation.
7. Finding patterns in genomes.

Reference Books:-

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.

2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.

PTC-310	Downstream Processing Lab (B.Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**2**	**1**	**60**	**40**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with different Downstream Processing techniques**						
Course Outcomes							
CO1	Students will learn how to lyse the cell						
CO2	Students will learn different chromatography used in DSP						
CO3	Students will work on purification of antigen						
CO4	Students will work on cell lysis by different methods						

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS

1. Purification of bacterial protein

a) Cell lysis by different methods and Cell debris separation by different methods.

b) Column purification

I. Separation by Molecular weight and charge

II. Separation by metal affinity and Receptor-Ligand affinity.

c) Dialysis, Crystallization andLyophilization

2. Purification of O-PS

a) Cell lysisand harvesting of cells

b) Purification of O-PS antigens

References:

1. Biophysical Chemistry: Principles & techniques 2nd Edition. Upadhyay, A.; Upadhyay, K. and Nath, N. (2002) Himalaya Publication House, New Delhi.
2. Bioprocess Engineering: Systems, Equipment & facilities. Eds. Lydersen K.B.; D'elia N.A. and Nelson K.L. (1994) John Wiley & Sons, New York.
3. Physical Biochemistry 2nd Edition. Friefelder D. (1983) W.H. Freeman & Co., USA.
4. Physical Biochemistry: Principles & applications. Sheehan David (2000) John Wiley & Sons Ltd. New York.
5. Bioseparations- Downstream processing for biotechnology. Belter, P.A.; Cussler, E.L. and Hu, W.S. (1988) John Wiley and Sons, New York.

PTC-312	Animal and Plant Biotechnology Lab (B. Tech Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**4**	**2**	**60**	**40**	**100**	**3Hrs**
Purpose	To learn practical concept and procedures for animal and Plant ,Cell and Tissue culture						
	Course Outcomes						
CO 1	To Learn Sterilization techniques and media preparation for plants						
CO 2	To micro propagate plants via direct and indirect methodology						
CO 3	Learning of Sterilization Techniques used in Animal cell culture Lab and Preparation of reagents and media for cell culture.						
CO 4	Students will learn Quantification of cells						

List of Experiments

1. Laboratory set up for plant cell and tissue culture.
2. Preparation of culture media, Nutrients and stock solutions.
3. Handling and sterilization of glassware and Plant parts.
4. Establishment of callus culture using different explants.
5. Inoculation and subculture for mass propagation of plant and callus culture
6. To study different development stages for somatic embryogenesis
7. Direct Plant regeneration from explants
8. Packing and sterilization of glass and plastic wares for cell culture.
9. Preparation of reagents and media for cell culture
10. Primer culture technique chicken embryo fibroblast.
11. Quantification of cells by trypan blue exclusion dye.
12. Study of effect of toxic chemicals on cultured mammalian cells

Text Books

1. Plant Tissue Culture. Theory and Practical. Bhojwani, S. S. and Rajdan,M.K.(1996).Elsevier, Amsterdam.

HSMC-301	(B.Tech. Biotechnology Semester VI) Engineering Economics						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	The course aims at providing the students with advanced concepts of engineering economic analysis and it's role in engineering decision making and also covers topics such as inflation, deflation, and estimation of future events.						
	Course Outcomes						
CO 1	Describe the role of economics in the decision making process and perform calculations in regard to interest formulas.						
CO 2	Estimate the Present, annual and future worth comparisons for cash flows						
CO 3	Calculate the rate of return, depreciation charges and income taxes.						
CO 4	Enumerate different cost entities in estimation and costing.						

Unit- I

- **Introduction**: Definition Nature Scope and Significance of Economics for Engineers.
- **Demand and Supply:** Demand – It's meaning,Types,Determinants, Law of Demand, Elasticity Of Demand and it's types, concept of Supply- it's determinants , Law of supply
  Market price determination, Demand Forecasting - it's Meaning,Methods, Consumer Survey-Trend Projections – Moving average.

Unit- II

- **Cost and Revenue:** Concepts – Classifications-Short run and long run cost curves-Revenue-Concepts – Measurement of Profit (Case Study).
- **Market Structure:** Perfect Competition- it's Characteristics Price and output in short run and long run, Monopoly Price Discrimination, Monopolistic Competition-Product Differentiation-Oligopoly and Duopoly.

Unit-III

- **Market Failure:** Causes Type of Goods Rivalrous and Non-rivalrous goods – Excludable and Non-excludable goods
- **Money and Banking:** Money – it's Functions , Quantity theory of money, Banking- Commercial Banks ,it's Functions , Central Bank (RBI) – it's Functions , Role of Banks in Economics development .

Unit-IV

- **Foreign Exchange:** Balance of Payments , Exchange rate determination , Methods Of foreign payments , International Institutions- IMF, IBRD.
- **Business Cycle and National Income**: Meaning-Phases of business cycle, Inflation - it's Causes , Control measures, Deflation, National Income – it's Concepts and Methods of Calculating national income , Problems in calculating national income.

Text Books:

1. Premvir Kapoor. "Sociology & Economics for Engineers", Khanna Publishing House, 2018.
2. Dewitt. K.K., Navalur M. H., "Modern Economic Theory". S. Chand and Company Ltd, New Delhi,24thEdn., 2014
3. Lipsey& Chrystal, "Economics", Oxford University Press, 2010.

References:

1. Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.
2. Francis Cherinullem "International Economics", McGraw Hill Education, 2011.
3. William A McEachern and Simrit Kaur, "Micro ECON", Cengage Learning, 2013.
4. William A McEachern and Indira A., "Macro ECON", Cengage Learning, 2014.

HSMC-302	(B.Tech Biotechnology Semester VI) Management - I , Organisational Behaviour						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**-**	**3**	**75**	**25**	**100**	**3 Hr**
Purpose							
	Course Outcomes						
CO 1	An overview about organizational behavior as a discipline and understanding the concept of individual behavior.						
CO 2	Understand the concept and importance of personality, emotions and its importance in decision making and effective leadership.						
CO 3	Enabling the students to know about the importance of effective motivation and its contribution in group dynamics and resolving conflicts.						
CO 4	Understand how to overcome organizational stress by maintaining proper organizational culture and effective communication.						

Unit- I

Introduction to organizational behavior: Concept and importance of organizational behavior, role of Managers in OB, challenges and opportunities for OB.

Foundation of individual behavior: Biographical characteristics, concept and types of abilities , concept of values and attitude, types of attitude, attitude and workforce diversity.

Unit- II

Introduction to personality and emotions: Definition and Meaning of Personality, Determinants of Personality, Personality Traits Influencing OB, Nature and Meaning of Emotions, Emotions dimensions, concept of Emotional intelligence.

Perception and individual decision making: meaning of perception, factors influencing perception, rational decision making process, concept of bounded rationality. Leadership-trait approaches, behavioural approaches, situational approaches, and emerging approaches to leadership.

Unit-III

Motivation: Concept and theories of motivation, theories of motivation-Maslow, two factor theory, theory X and Y, ERG Theory, McClelland's theory of needs, goal setting theory, application of theories in organizational scenario, linkage between MBO and goal setting theory.

Foundations of group behavior and conflict management: Defining and classifying of groups, stages of group development, Informal and formal groups- group dynamics, managing conflict and negotiation , causes of group conflicts, managing intergroup conflict through resolution.

Unit-IV

Introduction to Organizational Communication: Meaning and importance of communication process, importance of effective communication, organizational stress: definition and meaning sources and types of stress, impact of stress on organizations, stress management techniques.

Introduction to Organization Culture: Meaning and nature of organization culture, types of culture, managing cultural diversity, managing change and innovation-change at work, resistance to change, a model for managing organizational change.

Text Books:

1. Colquitt, Jason A., Jeffery A. LePine, and Michael Wesson. Organizational Behavior: Improving Performance and Commitment in the Workplace. 5th ed. New York: McGrawHill Education, 2017.

2. Hitt, Michael A., C. Chet Miller, and Adrienne Colella. Organizational Behavior. 4th ed. Hoboken, NJ: John Wiley, 2015.

3. Robbins, Stephen P., and Timothy Judge. Organizational Behavior. 17th ed. Harlow, UK: Pearson Education, 2017. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

Reference Books:

1. Schermerhorn, Hunt and Osborn, Organisational behavior, John Wiley.

2. Udai Pareek, Understanding Organisational Behaviour, Oxford Higher Education.

3. Mc Shane & Von Glinov, Organisational Behaviour, Tata Mc Graw Hill.

4. Aswathappa, K., Organisational Behaviour– Text and Problem, Himalaya Publication.

HSMC- 303	(B.Tech Biotechnology Semester VI) Operations Research						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	To make the students aware various optimization techniques used for solving engineering problems						
	Course Outcomes						
CO 1	To study necessity, application, scope related to industry. To make the students aware f linear programming and its graphical representation						
CO 2	To minimize the transportation cost using transportation models. To discuss and understand the network analysis representations						
CO 3	To understand simulation. Its applications, merits and demerits. Furthermore decision theory is also helpful to solve various engineering problems.						
CO 4	To Solve the problems related to Queuing theory and game theory						

Unit- I

Introduction: Definition and Development of Operations and scope of OR in industry, Operation Research in decision making ,Fields of application, Difficulties and limitations of OR

General Linear Programming Problems:
Introduction Maximization and minimization of function with or without Constraints, Formulation of a linear programming problem, Graphical method and Simplex method, Big M method, Degeneracy.

Unit- II

The Transportation Problems: Mathematical formulation, Optimality test the stepping stone method and MODI method, Modified Distribution Method, Vogels Approximation Method, Solution of balanced and unbalanced transportation problems and case of degeneracy, Assignment problems, Assignment modal Formulation Hungarian method for optimal solution Solving unbalanced problem.

Network Analysis: CPM/PERT, Network Representation, Techniques for drawing network, Numbering of events (Fulkersen Rule) ,PERT calculations- Forward path, back-ward path, Slack, probability, comparison with PERT, Critical path. Float, Project cost, Crashing the net work, updating (PERT and CPM).

Unit-III

Simulation Basics concept of simulation, Applications of simulation, Merits and demerits of simulation, Monte Carlo simulation, Simulation of Inventory system, Simulation of Queuing systems

Decision Theory: Steps in decision theory approach, Decision Machinery environment, Decision

machining under certainty and uncertainty, Decision machining under condition of risk, Decision trees, Minimum enchained criteria, Advantages and limitations of decision tree solutions, Post Optimality.

Unit-IV

Queuing Theory: Introduction, Applications of queuing Theory, Waiting time and idle time costs Single channel queuing theory and multi Channel queuing theory with Poisson arrival and exponential services, Numerical on single channel and multi channel queuing theory

Game Theory: Theory of games, competitive games, Rules and Terminology in game Theory, Rules for game theory saddle point, dominance Mixed strategy (2* 2 games), Mixed strategy 2 *n games or m*2 games for game Theory) Mixed strategy (3 x3 game)Two person zero sum games, N-person zero sum games.

Text Books:

1. JK Sharma, "Operations Research Theory & Applications, 34, Macmillan india Ltd, 2007 2. P.K. Gupta and D. S. Hira, "Operations Research", S. Chand & zo, 2007.
2. Introduction to Operations Research, by F.S. Hillier and G.J. Lieberman, seventh edition, McGraw Hill publications.

Reference Books :

1. Introduction to Mathematical Programming by Winston, WI (4^{th} ed.). Duxbury Press.
2. Operations Research by P Sankara lyer, Mc Graw Hill publications.

HSMC-304	Effective Technical Communication (B.Tech Biotechnology) Semester- VI						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3 hrs**
Purpose	**To familiarize the students with the effective communication skills**						
Course Outcomes							
CO1	Develop basic understanding of Communication						
CO2	Understand the process of communication and speaking.						
CO3	Develop the Personality concepts and its implementation.						
CO4	Develop the basic of group Discussion and interview.						

Unit I

Communication: Introduction, Types of communication, extra personal communication, inter personal communication, intrapersonal communication, mass communication, Creativity in communication, Role of communication, flow of Communications and its need, gesture and posture while communication

Unit II

Barriers in the way of communication, noise, inter personal barriers, intrapersonal barriers, organizational barriers, extra personal barriers, Basics of communication: importance of communication, process of communication, role of professional communication and its strategy.

Unit III

Personality Development, what is personality? Role of personality, Heredity, Environment, situation, Basics of personality, speaking skills: behavior and fluency in speaking skill, introduction and need of speaking skill.

Unit IV

Group discussion: Form of group discussion, strategy for group discussion, discussing problem and solution. Resume making: Purpose of Resume, Resume design and structure, contents in Resume, types of Resume, job interview, introduction, objective of Interview, types of interview, stages of interview, Face to face interview and campus interview.

Text Books/References:

1. Technical Communication Principles and Practice by Meenakshi Raman and Sangeeta Sharma by Oxford Publication.
2. Personality Development and soft skills by Barun K. Mitra ,Oxford Publication
3. Communication Skills For Engineers by C. Muralikrishna and Sunita Mishra , Pearson Pub