Scheme of Teaching

&

Detailed Syllabus

For

Masters in Technology
Biotechnology

M. Tech (BT)

(Two Year Program)

(w.e.f. Academic Session 2018–19)

School of Engineering & Technology
Shobhit Institute of Engineering & Technology

(Deemed to-be University)

NH-58, Modipuram, Meerut (U.P.) – 250110

Website: www.shobhituniversity.ac.in

M. Tech. (Biotechnology)

Choice Based Credit System

1st year (I Semester)

Course Code	Course/ Title	L	T	P	Cr
BTMT-501	Fundamentals of Biostatistics	3	1	0	4
BTMT-503	Applied Plant and Animal Biotechnology	3	1	0	4
BTMT-505	Advanced Computational Biotechnology	3	1	0	4
BTMT-507	Microbial Biotechnology	3	1	0	4
BTMT-553	Applied Plant and Animal Biotechnology Lab	0	0	3	2
BTMT581	Seminar	0	0	3	2
CSMT-509	Fundamentals of Computers and Programming	2	1	0	3

Total 23 Credits

1st year (II Semester)

Course Code	Course/ Title	L	T	P	Cr
BTMT-502	Advanced Immunotechnology	3	1	0	4
BTMT-504	Advanced Bioprocess Engineering	3	1	0	4
BTMT-506	Applied Recombinant DNA Technology	3	1	0	4
BTMT-522 BTMT-524	Engineering Principles in Biotechnology/ Tissue Engineering	3	1	0	4
BTMT-556	Applied Recombinant DNA Technology Lab	0	0	3	2
BTMT-582	Seminar	0	0	3	2

Total 20 Credits

2nd year (III Semester)

Course Code	Course/ Title	L	T	P	Cr
BTMT-601	Bioinstrumentation	3	1	0	4
BTMT-603	Downstream Processing and Bioseparation	3	1	0	4
BTMT-605	Food Engineering and Quality Control	3	1	0	4
BTMT-621 BTMT-623	Metabolic Engineering/ Nanobiotechnology	3	1	0	4
BTMT-671	Minor Project	0	0	4	2
BTMT-681	Seminar	0	0	3	2

Total 20 Credits

2nd year (IV Semester)

Course Code	Course/ Title	L	T	P	Cr
BTMT-692	Dissertation	0	0	28	14

Total Credits-77

Program Outcomes (POs):

PO 1. Biochemistry Majors will gain proficiency in basic laboratory techniques in both chemistry and biology, and be able to apply the scientific method to the processes of experimentation and hypothesis testing.

PO 2. Senior Biochemistry Majors will be able to demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.

PO 3. Students in the Biochemistry Major will be able to apply and effectively communicate scientific reasoning and data analysis in both written and oral forums.

PO 4. Students in the Biochemistry Major will understand and practice the ethics surrounding scientific research.

PO 5. Graduates will be able design, perform experiments, analyze and interpret data for investigating complex problems in biochemical engineering and related fields.

PO 6. Graduates will be able to decide and apply appropriate tools and techniques.

PO 7. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological engineering practices

PO 8. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.

PO 9. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO 10. Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.

PO 11. Recognize the need for, and an ability to engage in life-long learning.

PO 12. Graduates will be able to demonstrate knowledge of project and finance management when dealing with Biochemical problems.

Program Specific Outcomes (PSOs):

PSO 1. Demonstrate proficiency in basic science and foundation engineering courses.

PSO 2. Demonstrate a working knowledge of advanced biochemistry and life science for the industrial applications and human welfare.

PSO 3. Demonstrate the application in biotechnology and allied industries designing, developing and providing solutions for product/processes/technology development.

SEMESTER-I

Course code	**BTMT-501**				
Category	**Engineering & Technology**				
Course title	**FUNDAMENTALS OF BIOSTATISTICS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to teach students statistics measurement of parameters used in biological sciences. The course is designed to teach students the utility of set of experimental methods in biological research in a problem-oriented manner.				
Outcomes	1. Ability to calculate summary statistics from biomedical data 2. Ability to interpret written and visual presentations of statistical data 3. Evaluate and interpret results of descriptive statistics and regression methods. 4. Ability to choose the most appropriate statistical method to answer your research question 5. Statistical analysis through softwares.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Mean, Median, Mode, Variance and Deviation:** Measure of central tendency and location (mean, median, mode and location averages), relation between mean, median and mode with numerical examples. Statistics of dispersion: variability, range, mean deviation, deviation about median, standard deviation, variance, coefficient of quartile deviation, coefficient of variation, coefficient of dispersion, four central moments, skewness and Kurtosis. Relationship of life sciences with mathematics.	**8 Hrs**
Unit-2	**Probability and Probability Distribution:** Review of set theory, basic terminology, definition of probability, addition and multiplication rule of probability, conditional rule of probability, Bayes' theorem, probability mass function and probability density function, binomial distribution, Poisson distribution, hyper geometric, uniform, exponential and normal distribution	**6Hrs**
Unit-3	**Testing Hypothesis:** Types of errors, testing means, Significance of difference between means using Z- score; large sample test based on normal distribution- test based on 't' and F distributions,	**6Hrs**

	$\chi 2$ (chi square) test for goodness of fit and $\chi 2$ (chi square) test for independence of attribute, homogeneity and variance of a normal population.	
Unit-4	**Correlation Regression and Analysis of Variance (ANOVA):** Karl Pearson correlation coefficient, rank correlation, linear and multiple regressions, one way and two-way classification of ANOVA- application from biological sciences- case studies.	**6 Hrs**
Unit-5	**Mathematical models in Bio and Chemo system:** General linear model; Optimal prediction models; Genetical theory of Natural selection: Darwin, Lamarck and Mendel's contribution; Population growth: Logistic equation/Verhulst-Pearl model; Ecological predator-prey model: Lotka-Volterra model.	**6Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	2	1	1	2	2	1	3	3	1	-	2	3	3	-
CO 2	1	1	2	3	2	3	2	3	2	3	2	1	2	2	2
CO 3	3	2	2	2	2	2	2	3	3	2	2	3	2	2	2
CO 4	3	2	3	3	2	2	1	2	1	1	3	2	3	1	2
CO 5	3	2	1	3	3	-	3	2	1	1	3	2	2	2	2
Average	**2.6**	**1.8**	**1.8**	**2.4**	**2.2**	**2.3**	**1.8**	**2.6**	**2.0**	**1.6**	**2.5**	**2.0**	**2.4**	**2.0**	**2.0**

References

1. Zar, J.H. 2009. Biostatistical Analysis (5th eds.). Pearson Education Inc.2.

2. Miller, I.R., Freund, J.E. and Johnson, R. 1992. Probability and Statistics for Engineers (4th eds.), Prentice- Hall of India Pvt. Ltd.

3. Grafen, A. and Hails, R. 2008. Modern Statistics for the Life Sciences, Oxford University Press.

Course code	**BTMT-503**				
Category	**Engineering &Technology**				
Course title	**APPLIED PLANT AND ANIMAL BIOTECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to build upon postgraduate level knowledge of principles, methods and techniques involved in applied plant and animal technology. The course shall make the students aware of recent trends and context of each				

	relevant topic.
Outcomes	1. Students will acquire knowledge about differentially expressed genes 2. Students will acquire knowledge about the structure and function of chloroplast and mitochondria 3. Students will acquire knowledge about secondary metabolites synthesis 4. Students will acquire knowledge about agrobacterium and plant viruses 5. Students will acquire knowledge about molecular pharming

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Cell and tissue culture:** Brief history of plant tissue culture, basic techniques of plant tissue culture, media formulation and sterilization, callus culture, cell suspension culture, protoplast culture and somatic hybridization, cybrids, Anther culture, pollen culture, development of androgenic haploids, somaclonal and gametoclonal variations, micro-propagation, embryo culture and embryo rescue, secondary metabolites in plant culture.	**6 Hrs**
Unit-2	**Animal Cell and Tissue Culture Technology:** Basic concepts of animal cell culture, scale up culture of animal cells and their commercial scale production, scale up production of adherent and suspension cells, bioreactor and use of animal cell culture, Cell viability, cell counting and method of cell characterization, cell toxicity: apoptosis and necrosis, cell synchronization, method of cell synchronization.	**6Hrs**
Unit-3	**Methods for gene transfer in plants:** Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer, **Genetic Transformation-** Agrobacterium-mediated gene delivery; selectable and scorable markers, co-integrate and binary vectors and their utility; direct gene transfer methods **Transgenesis -** Production of transgenic plants for biotic and abiotic stress tolerance, chloroplast engineering, approaches for production of therapeutic proteins, vaccines, antigens, antibodies etc.	**6Hrs**
Unit-4	**Methods for gene transfer in animals:** Gene transfer methods in animal cell, chemical tranfection, physical transfection: ultrasound transfection, use of viruses as gene transfer vectors: Aderoviral, Baculoviral, unarmed herpes, retroviral and vaccinia viral vectors.	**6 Hrs**
Unit-5	**Biotechnology in livestock production:** Selected traits and their breeding into livestock, diagnosis, elimination and breeding strategies of genetic diseases, hybridization-based markers, PCR based markers, properties of molecular markers, transgenic breeding strategies. Role of animal cell culture in human and animal vaccines, hybridoma technology and pharmaceutical proteins. Role of cell culture tissue engineering.	**6Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	3	2	3	1	2	-	3	1	3	3	3	3
CO 2	1	1	2	3	2	1	2	3	2	3	2	1	2	2	2
CO 3	3	3	-	2	2	3	2	3	3	2	2	3	2	1	3
CO 4	2	2	3	1	2	2	1	1	2	1	3	2	2	2	2
CO 5	2	2	2	3	2	3	1	2	-	3	1	3	3	3	3
Average	**2**	**2**	**1.8**	**2.4**	**2**	**2.4**	**1.4**	**2.2**	**1.4**	**2.4**	**1.8**	**2.4**	**2.4**	**2.2**	**2.6**

References

1. Bhojwani, S.S. and Razdan, M.K. 2004. Plant tissue culture: Theory and Practice, (2nd eds.). Panima Publications.
2. Hartmann, H.T. and Kester, D.E. 2002. Plant propagation principles and practices (6th eds.). Prentice Hall India.
3. Ramawat, K.G. 2008. Plant biotechnology (3rd eds.). S. Chand Publications, New Delhi.
4. Singh, B.D. 2008. Biotechnology- Expending Horizons (2nd eds.). Kalyani Publications.
5. Gupta, P.K. Elements of Biotechnology, Rastogi Publications.
6. Chawla, H.S.2003. Plant biotechnology. Special Indian edition.Oxford and IBH Publishers.Primrose, S.B. and Twyman, R.M. 2008. Principles of gene manipulation and genomics (7th eds.).
7. Kaushik, A. and Kaushik, C.P. Plant Genetic Engineering. New Age International Publishers.

Course code	**BTMT-505**				
Category	**Engineering & Technology**				
Course title	**ADVANCED COMPUTATIONAL BIOTECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to take students through basics of computational tools constructed from biological experimental measurements. On covering all classical concepts and models of computational biology students will be awared with recent tools of computational biology.				
Outcomes	1. Learn the basic tools & techniques used in applications of Bio-informatics. 2. Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics. 3. Explain about the methods to characterize and manage the different types of biological data. 4. Classify different types of Biological Databases. 5. Introduction to the basics of sequence alignment and analysis				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction to major Bioinformatics resources on the web:** Biological databases, specialized databases, nucleic acid sequence databases, GenBank, EMBL, DDBJ, protein sequence databases, PIR-PSD, ExPASy, SwissProt, TrEMBL, GenBank, GenPept, database searches, text-based searching, simple and advanced forms, manipulation of displays, Entrez/SRS- query engines, exploring EMBOSS series.	**6 Hrs**
Unit-2	**Sequence-alignment related problems and pattern analysis in sequences** Similarity matrices, pairwise and MSA, statistical significance of alignment, phylogenetics, distance based approaches, maximum parsimony,analysis of domains, motifs and folds in sequences, consensus sequences, regular expressions, Markov models, regulatory sequence identification using MEME, gene identification and its validation.	**6Hrs**
Unit-3	**Structural analysis** Representation of molecular structures prediction of structure of RNA, protein structure by comparative modeling, homology modeling, threading, Ab initio structure prediction, force fields, energy minimization, molecular dynamics, protein ligand docking, CADD, QSAR, protein-protein interaction, structural classification (SCOP,	**6Hrs**

	CATH), visualization software (Pymol, Rasmol).	
Unit-4	**Systems Biology basics and applications** System-level understanding of biological systems, use and integration of data from transcriptomics, proteomics and metabolomics; concepts in glycomics, interactomics and fluxomics.	**6 Hrs**
Unit-5	**Introduction to languages used in Bioinformatics** Perl, Python, Unix and Linux, basic commands and syntaxes in the three. Understanding of file systems. Application of languages in Biological data	**6Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	2	2	1	2	2	2	1	2	3	3	3
CO 2	1	2	2	-	2	-	2	3	2	3	2	3	2	2	2
CO 3	3	2	2	2	3	2	2	3	3	2	2	3	2	2	2
CO 4	2	2	3	1	3	2	1	1	1	2	3	2	3	2	-
CO 5	3	2	1	3	1	1	2	2	1	2	1	2	2	-	2
Average	**2.4**	**2.0**	**2.0**	**1.8**	**2.2**	**1.8**	**1.6**	**2.2**	**1.8**	**2.2**	**1.8**	**2.4**	**2.4**	**2.3**	**2.3**

References

1. Pevzner, P.A. 2000. Computational Molecular Biology: An Algorithmic Approach.
2. Clote, P. Formerly and Backofen, R., 2000. Computational Biology: An Introduction. John Willy and Sons Ltd.
3. Fasman D., 1989. Prediction of Protein Structure and Principle of Protein Conformation, Plenum Press, New York.
4. Tisdall J. 2001. Beginning Perl for Bioinformatics, O'Reilly Publisher.

Course code	**BTMT-507**				
Category	**Engineering & Technology**				
Course title	**MICROBIAL BIOTECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to build knowledge of prokaryotic and eukaryotic diversity with specific emphasis on mechanisms behind it. The course shall make the students aware of various microbial communities and within the context of each topic.				

Outcomes	1. To highlight the roles and characteristics of microorganisms in field of Biotechnology. 2. To impart knowledge on the basic concept of multiplication in microorganism. 3. To study in detail the growth, genetic organization of microorganisms and impact of environment on their growth. 4. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

S. No.	Unit details	Time Allotted
Unit-1	**Introduction of microbes, taxonomy and classification** Introduction to bacteria, fungi, and viruses, structural and cellular organelles differences among different types and classes; biochemical/microscopic/molecular methods to differentiate archaea, eubacteria and eukaryotes; microbial evolution, systematics and taxonomy-new approaches to bacterial taxonomy, classification including ribotyping, characteristics of primary domains, taxonomy, nomenclature and Bergey's manual, ribosomal RNA sequencing.	**6 Hrs**
Unit-2	**Unit II:** **Growth and nutrition:** Prokaryotic growth patterns and functions - microbial nutrition and growth - arithmetic and geometric growth expression, growth kinetics, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, diauxic growth, culture collection and maintenance of cultures.	**6Hrs**
Unit-3	**Microbial Genetics:** Microbial regulation of gene expression (attenuation and negative regulation with e.g. *trp* and *lac* operon), transfer of genetic material: plasmids, transposons, transduction, transformation and conjugation. Mutations and their chemical basis; mutagens and their use in biotechnology; modes of recombination; comparative prokaryotic genomics.	**6Hrs**
Unit-4	**Host-microbe interaction:** Normal micro flora of skin, oral cavity, gastrointestinal tract; entry of pathogens into the host, types of toxins (exo, endo, entro) and their mode of actions, plant -microbe interactions, microbial pathogenesis -disease reservoirs; epidemiological terminologies; infectious disease transmission.	**6 Hrs**
Unit-5	**Microbes based therapies:** Antimicrobial agents, sulfa drugs, antibiotics -penicillin and cephalosporins, broad spectrum antibiotics, antibiotics from prokaryotes. antifungal antibiotics; mode of action, resistance to antibiotics. Bacteriophage therapy. Potential targets for drug design.	**6 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

CO 1	1	2	2	3	2	3	2	3	2	3	2	-	2	2	2
CO 2	3	2	3	2	2	2	3	3	3	2	2	3	2	2	2
CO 3	2	2	3	2	2	2	2	2	2	-	-	2	3	2	3
CO 4	3	2	1	3	3	1	3	2	1	1	1	2	2	2	2
Average	**2.3**	**2.0**	**2.2**	**2.2**	**2.4**	**2.0**	**2.2**	**2.6**	**2.0**	**1.8**	**1.5**	**2.3**	**2.4**	**1.8**	**2.4**

References

1. Reed G. 1997. Industrial Microbiology. CBS Publishers. AVI Publishing Co.
2. Stanbury PF, Whitekar A. and Hall 1995. Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
3. Bhosh, Fiecht er and Blakebrough 1999. Advances in Biochemical Engineering. Springer Verlag Publications.
4. Creuger and Creuger 2001. Biotechnology- A textbook of Industrial Microbiology, Sinaeur Associates.
5. Casida LE 1997. Industrial Microbiology, Wiley Eastern. 6th edition

Course code	**BTMT-553**			
Category	**Engineering & Technology**			
Course title	**APPLIED PLANT AND ANIMAL BIOTECHNOLOGY LAB.**			
Scheme and Credits	**CR**	**L**	**T**	**P**
	2	0	3	0
Pre-requisites (if any)				
Objectives	The objective of this laboratory course is to introduce students to experiments in animal and plant biotechnology. The course is designed to teach students the utility of set of experimental methods in animal and plant biotechnology in a problem-oriented manner.			
Outcomes	Students will get awareness about the tools and techniques used in animal and plant biotechnology. Students would be able to use these techniques in their research projects.			

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	3	2	1	3	3	2	-	2	2	3	3
CO 2	3	2	1	3	1	1	3	2	1	1	1	2	2	2	2
Average	**2.5**	**2**	**2**	**2**	**2**	**1.5**	**2**	**2.5**	**2**	**1.5**	**1**	**2**	**2**	**2.5**	**2.5**

List of experiments.

1. Selection, preparation and sterilization of explant and laboratory wares.
2. Aseptic culture techniques for establishment and maintenance of cultures.
3. Preparation of stock solutions of MS (Murashige and Skoog) basal medium and plant growth regulator stocks.
4. Production Callus from different tissues of plant.
5. Isolation and culture of protoplasts.
6. Plant regeneration by embryo/ anther /pollen culture.
7. Introduction to Cell Culture lab and aseptic skill; (Use of Biosafety cabinet, CO_2 incubators, Microscopes, Sterile Conditions),
8. Preparation of Cell Culture Media and other supplements & Additives,
9. Isolation and Culturing of MNCs from Peripheral blood,
10. Cell counting & cell morphology,
11. Introduction to type of bioreactors & their operation; (Spinner Flask, Rotating vessel, Perfused Column and Perfused Chamber),
12. Culture and cell growth study in bioreactor,
13. Cell Survival & Function; Live/Dead Fluorescence Assay; MTT Viability Test; Cell Viability Test by Trypan Blue staining method.

Course code	**CSMT-509**				
Category	**Engineering & Technology**				
Course title	**FUNDAMENTALS OF COMPUTERS & PROGRAMMING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	0	2	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to take students through fundamentals computational tools constructed from biological experimental measurements. On covering programming languages concepts of computational biology students will be				

	awared with recent tools of computational biology.	
Outcomes	1. Understand computer basics and programming basics. 2. Understand binary number system 3. Begin using the Java programming language and Display output on the console. 4. Explain the differences between syntax errors, runtime errors, and logic errors.	
S. No.	**Unit details**	**Time Allotted**
Unit-1	**Computer networking:** Computer networking**:** Introduction to networking: various terminologies. Associated hardware devices, gadgets (Router, Switch etc.), tools, services, and resources. Network Topologies and Protocols. LAN, WAN and MAN, World Wide Web (WWW) Network security: fire walls. Search engines: Google, Yahoo etc. Concepts in text-based searching. Searching Medline, bibliographic databases.	**6 Hrs**
Unit-2	**Programming concepts:** Algorithms, flowcharts & programming concepts: Algorithms: Concepts & definitions, Converting algorithms to flowcharts, coding: flowcharts to programs, comparing algorithms, flowcharts & programs.	**6Hrs**
Unit-3	**Operating systems:** Introduction to operating systems: operating system concept, Windows 98/XP, Windows server NT/2000, UNIX /Linux & servers. Data processing & presentation**:** Introduction, MS office (World, Excel & Power Point). Computer viruses**:** An overview of Computer viruses. What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General precautions.	**6Hrs**
Unit-4	**Generation of computers:** History: Evolution, Generation of computers (I, II, III, IV, V). Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost, size. Modern computers**:** The work station, The Minicomputer, Mainframe. Computers, Parallel processing Computer & the Super Computer.	**6 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	2	3	2	1	2	3	2	3	2	1	-	3	2
CO 2	2	3	2	2	2	1	2	3	3	2	2	3	2	2	2
CO 3	2	2	3	2	2	2	1	2	2	1	3	-	1	3	3
CO 4	3	2	2	3	1	1	3	2	1	1	1	2	2	2	2
Average	**2.3**	**2.0**	**2.3**	**2.5**	**1.8**	**1.3**	**2.0**	**2.5**	**2.0**	**1.8**	**2.0**	**2.0**	**1.7**	**2.5**	**2.3**

References	1. Introduction to Computers Data processing & Networking 2. Computer Fundamentals – P.K. Sinha 3. Programming in C- E.Balaguru Swamy. 4. C++ from Scratch. J.Liberty. 5. How computers work. 2000. ron White. Techmedia.

SEMESTER-II

Course code	**BTMT-502**				
Category	**Engineering and Technology**				
Course title	**ADVANCED IMMUNOTECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course isto introduce concepts of immune system to students. The course is designed to teach students the utility of immunotechniques and immunoseperation experimental methods in a problem-oriented manner.				
Outcomes	1. Describes the basics of modern immunotechnology, the development of the products of the immunotechnology, the application of immunological methods in biotechnology, pharmacy, diagnostics, therapy and scientific investigation; 2. Explains the connection between immunotechnology and other nature sciences. 3. Explains the importance of immunotechnology for the development of other sciences, the input of immunotechnology to the biotechnology. 4. Explains the basic use of the concepts of immunotechnology, adapting them to the laboratory work; analyzes and summarizes the scientific information.				
S. No.	**Unit details**				**Time Allotted**

Unit-1	**Fundamentals of Immunology:** Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; haematopoesis; organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; mucosal and cutaneous associated lymphoid tissue. (MALT & CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.	**6 Hrs**
Unit-2	**Molecular basis of Immune responses:** Humoral immune response: Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; immunoglobulin superfamily; principles of cell signaling; immunological basis of self – non-self-discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; Cell-mediated immune responses: T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets, ADCC; cytokines-properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system, plantibodies.	**6Hrs**
Unit-3	**Antigen-antibody interactions and Immonotechniques** Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock out animals, hybridoma technology.	**6Hrs**
Unit-4	**Vaccinology** Active and passive immunization; live, killed, attenuated, sub unit vaccines; vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, edible vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries.	**6 Hrs**
Unit-5	**Clinical Immunology and human health** Immunity to infection: bacterial, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; autoimmunity; types of autoimmune diseases; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the	**6Hrs**

	immune system, Cancer immunotherapy; immunodeficiency-primary immunodeficiencies, acquired or secondary immunodeficiencies.	

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	3	2	1	2	3	2	3	1	3	2	2	2
CO 2	3	2	-	2	2	2	2	2	3	2	2	3	2	2	2
CO 3	2	2	3	-	2	2	1	3	2	2	3	3	1	1	3
CO 4	1	2	1	3	1	3	3	2	1	1	1	1	2	2	2
Average	**1.7**	**2.0**	**2.0**	**2.6**	**1.7**	**2.00**	**2.00**	**2.5**	**2.0**	**2.0**	**1.7**	**2.5**	**1.7**	**1.7**	**2.2**

References

1. Moran, A. 2006. Immnunotechnology: Principles, concepts and applications, John Willey and Sons.
2. Rao, C.V. 2008. Immunology: A text book. Narosa Publishing House.
3. R.A., Kindt, T.J. and Osborne, B.A. Kuby's Immunology (4th eds.). W H Freeman and Company.
4. Tizard. 2008. Immunology: An introduction (4th eds.). Cengege learning.
5. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2008. Prescott, Harley and Klein's
6. Microbiology (7th eds.). Mc Graw Hill, USA.
7. Roitt et al. 2006. Essentials of immunology 11th edition. Blackwell Publisher.
8. Clackson, T. aand Lwman, B.H. 2004. Phage Display: A practical approach, Oxforford University Press.

Course code	**BTMT-504**			
Category	**Engineering and Technology**			
Course title	**ADVANCED BIOPROCESS ENGINEERING**			
Scheme and Credits	**CR**	**L**	**T**	**P**
	4	3	1	0
Pre-requisites (if any)	Nil			
Objectives	The objective of this course is to make aware the students about the downstream bioprocessing methods used in industry. The course is designed to teach students downstream processing concepts for commercial bio-products			
Outcomes	1. Explain the significance of downstream processing in bioprocess industry. 2. Evaluate primary separation techniques for product recovery.			

	3. Choose the techniques for product enrichment and purification. 4. Utilize membrane-based operations for product purification. 5. Apply downstream processing concepts for commercial bio-products.

S. No.	Unit details	Time Allotted
Unit-1	**Kinetics of Microbial Growth, and Product Formation:** Different modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, product formation kinetics, substrate and product inhibition on cell growth and product formation. Stoichiometry of cell growth and product formation.	**6 Hrs**
Unit-2	**Media design& Sterilization:** Medium requirements for fermentation processes different types of industrial sterilization, Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of depth filters, design of sterilization equipment - batch and continuous.	**6Hrs**
Unit-3	**Reactor Engineering:** General requirements of fermentation processes, basic design and construction of fermentor and ancillaries, reactors of specific applications: packed bed, bubble columns, fluidized bed and trickle bed bioreactors, bioreactor design for animal cell culture, and Bioreactor design for waste treatments. Solid-state fermentations and its applications. Active and passive immobilization of cells, diffusional limitations in immobilized cells, bioreactor considerations in immobilized cell.	**6Hrs**
Unit-4	**Transport Phenomena in Bioprocess Systems:** Gas – Liquid mass transfer in cellular systems, determination of oxygen rates, correlations for mass transfer coefficient and interfacial area, mass transfer across free surface, other factors affecting K_La, heat transfer correlations.	**6 Hrs**
Unit-5	**Measurement and control of Bioprocess:** On and off-line sensors for a modern bioreactor. Process control, direct regulatory control, cascade control, advanced control strategi0es. **Industrial Bioprocess:** Anaerobic process: ethanol, lactic acid, acetone-butanol production. Aerobic Processes: citric acid, baker's yeast, penicillin, high fructose corn syrup production**.**	**6Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	2	1	3	2	1	1	3	1	3	-	2	2	1
CO 2	3	-	2	3	2	1	2	3	2	3	2	1	2	2	3
CO 3	3	2	2	2	2	-	2	3	3	-	2	3	2	2	2
CO 4	2	2	3	3	2	2	3	3	2	1	3	2	3	3	2
CO 5	3	2	1	3	1	1	3	2	1	1	1	2	2	2	2

Average	**2.4**	**2.3**	**2.0**	**2.4**	**2.0**	**1.5**	**2.2**	**2.4**	**2.2**	**1.5**	**2.2**	**2.0**	**2.2**	**2.2**	**2.0**

References	1. Shuler, M.L. and Kargi, F. 2002. Bioprocess Engineering: Basic Concepts. 2nd Edition. Prentice Hall, 2. Lee, J.M., 1992. Biochemical Engineering, Prentice Hall Inc. 3. Bailey, J.E. & Ollis, D.F., 1986. Biochemical Engineering Fundamentals, 2nd ed., McGraw-Hill.

Course code	**BTMT-506**				
Category	**Engineering and Technology**				
Course title	**APPLIED RECOMBINANT DNA TECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to sensitize the students about the role of genes, genetic code, and genetic engineering in Biotechnology. The course is designed to teach students various techniques used in genetic engineering and gene therapies.				
Outcomes	1. Recall and relate the role of genes, genetic code, and genetic engineering in Biotechnology. 2. Describe the role of various enzymes in genetic manipulation. 3. Make the use of the techniques involved in isolation, purification and separation of nucleic acids. 4. Apply rDNA technology in various fields using suitable methodology. 5. Appraise the use of genetic engineering principles for gene therapies.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction and Scope:** Landmarks in molecular biology and biotechnology, what is genetic engineering and recombinant DNA technology, role of plasmids, phages, *E. coli* and, yeast, and other mammalian cells; genetic engineering guidelines including biosafety and ethics.	**6 Hrs**
Unit-2	**Tools in genetic engineering:** Enzymes- DNA polymerases, restriction endonucleases, ligases, reverse	**6Hrs**

	transcriptases, nucleases, terminal transferases, phosphatases etc.; different vectors based upon plasmids, bacteriophages and viruses, artificial chromosome, plasmid and hybrid vectors and shuttle vectors; concept of cloning vector and expression vector, different host systems.	
Unit-3	**Gene cloning and Expression:** Isolation and purification of DNA (genomic, plasmid) and RNA, isolation of gene, restriction digestion and ligation of DNA, linkers, adapters; methods of gene transfer in prokaryotic and eukaryotic cells, recombinant selection and screening methods, expression of cloned DNA molecules and maximization of expression, directional cloning strategy; genomic DNA libraries and cDNA libraries. Factors in the optimization of expression of cloned gene, heterologous gene expression, vector engineering, codon optimization, host engineering. Gene expression in bacteria, yeast, insects, mammalian cells and plants.	**6Hrs**
Unit-4	**Recombinant DNA techniques and its applications:** Molecular probes and nucleic acid labeling, analysis of gene expression; DNA sequencing basics and Next Generation Sequencing (NGS); PCR and its variants, mutagenesis; molecular markers- DNA fingerprinting, single nucleotide polymorphisms, RAPD, RFLP, AFLP; protein- protein interactions technique- two-hybrid and phage display techniques; detection using GST and other fusion proteins; gene deletion.	**6 Hrs**
Unit-5	**Recombinant vaccines and therapeutics**; gene therapy in vivo approach, ex-vivo approach; RNAi and antisense technology, ribozyme technology; Transgenics, knock out animals; genetic diversity; genetic disorders-diagnosis and screening; DNA microarrays; The Human Genome Project.	**6 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	3	2	1	3	2	3	1	3	3	2	2	1	3	1
CO 2	1	2	1	3	2	2	2	3	2	3	2	1	2	2	2
CO 3	3	2	2	2	2	2	2	3	3	2	2	3	1	2	3
CO 4	1	2	2	1	3	2	1	3	3	1	1	2	1	2	2
CO 5	3	2	1	3	1	1	3	2	1	2	1	2	2	2	2
Average	**1.8**	**2.2**	**1.6**	**2.0**	**2.2**	**1.8**	**2.2**	**2.4**	**2.4**	**2.2**	**1.6**	**2.0**	**1.4**	**2.2**	**2.0**

References

1. Primrose, S.B. and Twyman. 2008. R.M. Principles of gene manipulation and genomics (7th eds.). Blackwell Publishing.
2. Winnacker, Ernst-L. 2003. From Gene to Clone Introduction to gene technology. Panima publishing Corp., New Delhi.
3. Old, R.W. and Primrose, S.B. 2009. Principles of gene manipulation: An introduction to genetic engineering. Blackwell Science Publication.
4. Brown, T.A. 2008. Gene Cloning and DNA analysis (5th eds.). Blackwell Sciences LTD.
5. Gupta, P.K. 2008. Biotechnology and Genomics (1st ed.). Rastogi Publication,

	Meerut. 6. Ramawat, K.G. 2008. Plant biotechnology (3rd eds.). S. Chand Publications, New Delhi. 7. Singh, B.D. 2008. Biotechnology- Expending Horizons (2nd eds.). Kalyani Publications. 8. P.K. 2009. Elements of Biotechnology. Rastogi Publications., Meerut. 9. U. 2008. Biotechnology. Uppala Author Publisher Interlink.

Course code	**BTMT-556**				
Category	**Engineering and Technology**				
Course title	**APPLIED RECOMBINANT DNA TECHNOLOGY LAB.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	3	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this laboratory course is to introduce students to experiments in Recombinant DNA Technology. The course is designed to teach students the utility of set of experimental methods in RDTin a problem-oriented manner.				
Outcomes	On completion of this course, students should be able to: 1. To elaborate concepts of RDT with easy to run experiments; 2. To familiarize with basic laboratory instruments and understand and the principle of measurements using those instruments with experiments in RDT.				

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	2	1	3	2	2	3	1	2	-	2	3	2	3
CO 2	1	2	2	2	2	1	2	3	2	3	2	3	2	2	2
Average	1	2	2	1.5	2.5	1.5	2	3	1.5	2.5	2	2.5	2.5	2	2.5

S. No.	**Practical details**	**Time Allotted**
	1. General guidelines for working in rDNA technology. 2. Preparation of commonly used chemicals and reagents for rDNA technology lab. 3. Isolation of genomic DNA. 4. Agarose Gel Electrophoresis. 5. Digestion of DNA with restriction endonucleases. 6. Isolation of plasmid DNA.	

	7. Bacterial transformation. 8. Polymerase chain reaction. 9. Primer designing by software.	

Course code	**BTMS-524**				
Category	**Engineering and Technology**				
Course title	**TISSUE ENGINEERING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to take students through basics of tissue engineering and its applications All classical concepts and models of tissue engineering, biomaterials and tissue grafts will be explained.				
Outcomes	1. Describe the basic techniques to manufacture scaffolds from raw biomaterials and explain the different prerequisites for the biomaterials. 2. Explain nature design concepts in the biomaterials field. 3. Differentiate biomaterials regarding their properties and assess their usage in a specific application. 4. Describe the most common techniques to test cell biocompatibility of biomaterials and apply them on different biomaterials. 5. Correlate the protein structure of a biomaterial with its properties as a biomaterial.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction of Tissue Engineering**: Introduction and Extracellular matrix as a biologic scaffold for tissue engineering, Scaffold fabrication, bioactive scaffold, Natural polymers in tissue engineering applications, Degradable polymers for tissue engineering.	**6 Hrs**
Unit-2	**Implant – Cellular Interaction:** Types of implants in surgical uses and probability of implant failures. Protein interactions with implanted	**6Hrs**

	materials, cellular recognition of Proteins adsorbed on material surfaces, adhesion, migration, differentiation, Cellular Extra cellular Matrix deposition leading to tissue regeneration, foreign-body response, inflammatory response.	
Unit-3	**Stem cells and regenerative medicine:** Introduction to Stem cells, types of stem cells: Embryonic, Mesenchymal and Induced pluripotent stem cells. Stem cell-based tissue engineering products.	**6Hrs**
Unit-4	**Bioreactors:** Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers.	**6 Hrs**
Unit-5	**Transgenic animal production:** Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice.	**6Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	3	2	2	-	2	2	1	3	1	2	1
CO 2	1	2	2	3	2	1	2	3	2	3	2	1	2	2	2
CO 3	3	2	3	2	2	2	2	3	3	2	2	3	2	2	2
CO 4	2	2	3	1	2	2	1	2	1	3	1	2	2	2	-
CO 5	3	2	1	3	2	1	3	2	3	1	1	2	2	2	2
Average	**2.2**	**2.0**	**2.2**	**2.0**	**2.2**	**1.6**	**2.0**	**2.5**	**2.2**	**2.2**	**1.4**	**2.2**	**1.8**	**2.0**	**1.8**

References

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000

2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991

3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.

4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997

SEMESTER-III

Course code	**BTMT-601**				
Category	**Engineering and Technology**				
Course title	**BIOINSTRUMENTATION**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course is to make aware the students about the analytics and instruments used in the research The course is designed to teach students bio-instrumentalization concepts for their use in basic research.				
Outcomes	1. To understand the principles of analytic instruments used for qualitative and quantitative detection of chemical and biological components. 2. To display the conceptual and practical skills related to the spectroscopic methods and its current applications. 3. In-depth understanding of the working principles of mass spectrometry and identification of compatible technique. 4. Understanding the concepts related to the determination of quality control, purity and molecular structure of the sample through NMR. 5. Ability to develop logical lab reports and study designs using analytical techniques.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Principle and applications of electrophoresis:** Nucleic acid and protein separation, Isoelectric-focusing (IEF), 2-dimentional electrophoresis (2-DE), matrix assisted laser desorption ionization (MALDI-TOF) mass spectrometry, Surface enhanced laser desorption ionization (SELDI).	**6 Hrs**
Unit-2	**Centrifugation:** Basic principles common centrifuges used in laboratory (clinical high speed & ultra-centrifuges). Types of rotors (fixed angle, swing bucket). Types of centrifugations: preparative, differential & density gradient. Ultracentrifugation : sedimentation rate, equilibrium, density gradient, centrifugation and sedimentation coefficient.	**6Hrs**
Unit-3	**Basic principle and applications of microscopy in biology**: Concept of numerical aperture, magnification and resolution, lense. Light, phase contrast, fluorescent, confocal, microscopy.	**6Hrs**

	Scanning and transmission electron microscopy (SEM, TEM) atomic force microscope, total internal reflection fluorescence microscopy (TIRFM) in nanobioscience, higher harmonic generation microscopy, Live cell spinning disk microscopy.	
Unit-4	**Basic principle and different types of chromatography:** Gel exclusion, HPLC, HPTLC, GC, Affinity.	**6 Hrs**
Unit-5	**Biosensors**: Principles and definition, characteristics of Ideal biosensors, Basic measuring procedure, Biochemical components of biosensors, Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors **Application of Biosensors**: Clinical laboratory, In vivo determination of metabolites, Environmental monitoring of toxic compound.	**6Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	2	3	3	1	3	3	3	3	1	3	3
CO 2	1	1	2	3	2	1	3	3	2	3	2	2	2	2	2
CO 3	3	2	2	3	2	2	2	3	3	2	2	3	2	2	2
CO 4	2	2	3	2	2	2	2	1	2	3	3	2	3	3	2
CO 5	3	2	2	3	2	3	3	1	2	3	3	2	2	3	2
Average	**2.2**	**1.8**	**2.4**	**2.4**	**2**	**2.2**	**2.6**	**1.8**	**2.4**	**2.8**	**2.6**	**2.4**	**2**	**2.6**	**2.2**

References

1. Wilson, K. and Walker, J. 1994. Principles and Techniques Practical Biochemistry, Cambridge University Press, Cambridge.
2. Willard, H.H., Meritt, L.L., Dean, J.A. and Settle, F.A. 1986. Instrumental method of analysis (7th eds.). Wadsworth Pub. Co., USA.
3. Rana, S.V.S. 2006 and 07. Biotechniques– Theory and Practice (2nd eds.). Rastogi Publications.
4. Chatwal, G.R. and Anand, S.K. 2008. Instrumental methods of chemical analysis (5th eds.). Himalaya Publishing House.
5. Skoog, D.A., Holler, F.J. and Crouch, S.R. 2007. Instrumental analysis. Brooks/Cole Cengage Learning.
6. Upadhayay, A. and Upadhayay, K. 2008. Biophysical chemistry (4th eds.). Himalaya Publishing House.

Course code	**BTMT-603**				
Category	**Engineering and Technology**				
Course title	**DOWNSTREAM PROCESSING & BIOSEPARATION**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course is to make aware the students about the downstream bioprocessing methods used in industry. The course is designed to teach students downstream processing concepts for commercial bio-products.				
Outcomes	1. Perform bioreactor operations as applicable in bioprocess industries. 2. Scale-up, simulate and model bioprocess operation. 3. Carry out separation and purification of fermentation products.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction:** Scope of downstream processing in biotechnology, requirement and problems of purification, classes of bioproducts, physicochemical basis of bioseparation. **Cell lysis and flocculation:** biomass removal and cell disruption, chemical lysis, enzymatic lysis, physical and mechanical means of disruption, flocculation. **Sedimentation:** sedimentation principles, methods and coefficients, centrifuges, ultra-centrifugation, sedimentation of low accelerations.	**6 Hrs**
Unit-2	**Membrane separation process:** Filtration, filtration principles, ultrafiltration, electrophoresis, electrodialysis and isoelectric focusing, membrane for liquid-liquid extraction, reverse osmosis, separation of liquids, dialysis.	**6Hrs**
Unit-3	**Chromatography:** Classification, concepts of retention factor, capacity factor, partition coefficient, column efficiency; ion exchange chromatography, gas chromatography, gel filtration chromatography, HPLC, UFLC, affinity chromatography, adsorption, reverse phase chromatography etc.	**6Hrs**
Unit-4	**Distillation operations:** Basic principles of the following distillation operations, batch, continuous, flash, steam, vacuum, molecular	**6 Hrs**

	distillations, azeotropic and extractive distillation.	
Unit-5	**Extraction and Drying:** extraction, extraction principles, drying, drying principles, dryer description of operation. **Precipitation:** protein solubility, precipitate formation phenomena, methods of precipitation.	**6Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	2	3	1	1	3	1	3	2	2	-	3
CO 2	1	3	2	3	2	2	2	3	2	3	2	1	2	2	2
CO 3	3	2	3	2	2	2	2	1	3	2	3	3	2	2	2
CO 4	2	2	3	3	2	2	1	1	2	1	1	2	3	3	2
CO 5	3	2	1	3	2	1	2	2	2	1	1	2	2	2	1
Average	**2.2**	**2.2**	**2.2**	**2.4**	**2**	**2**	**1.6**	**1.6**	**2.4**	**1.6**	**2**	**2**	**2.2**	**2.25**	**2**

References

1. Treybal E. Robert. 1993. Mass-Transfer operations (3rd eds). McGraw-Hill International Edition, Singapore.
2. Doran M. Paulines. 2003. Bioprocess engineering principles (8th eds). Academic press, New York.
3. Warren, M.L., Julian, S.C. and Peter Harriott. 2001. Unit Operations of Chemical Engineering (6th eds). McGraw-Hill International Edition, New York.
4. Bailey, J. E. and Ollis, D.F. 1986. Biochemical Engineering Fundamentals (2nd eds.). McGraw-Hill Inc.

Course code	**BTMT-623**				
Category	**Engineering and Technology**				
Course title	**NANO-BIOTECHNOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course isto make aware the students about the nano technology advances. The course is designed to teach students conepts of nanotechnology and their applications in Biology				
Outcomes	1. Provide basic understanding about the new branch of biotechnology –Bio nanotechnology.				

	2. Functioning of Bionanomachines and its advantages and uses. 3. Knowledge about the Biomolecular design and the Biomolecular Structure determination and how it is in bio nanotechnology.

S. No.	Unit details	Time Allotted
Unit-1	**Introduction, History & Applications:** Definitions, history of nanotechnology, context of nanotechnology- materials, devices, systems. Significance of nano domain, issues of miniaturization, forces, device performance, design. Basic biology principles and practice of micro fabrication techniques. Nanoparticles, nanofibers, nanoplates, graphene-based materials, biological effects of nanoparticles.	**6 Hrs**
Unit-2	**Protein-based Nanostructures:** Nanobio-machines & Signalling Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged nano-particles. Cell as Nanobio-machine, link between the signaling pathways & molecular movements as well as neuron function, Concepts in nanobio-machines for information processing and communications.	**6Hrs**
Unit-3	**Microbial Nanoparticle Production:** Overview and concept of microbial nano-particle production, Methods of microbial nano-particle production Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications– overview, structure, photoelectric applications, photochromic applications and applications in energy conversion.	**6Hrs**
Unit-4	**DNA-Protein Nanostructures:** Overview and introduction, Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology.	**6 Hrs**
Unit-5	**Biomaterials & Bio-electronics:** Biomaterials- types, properties and applications, Biomaterial nano-particle systems for bio-electronic & bio-sensing applications, Biomaterial-based Nano-circuitry, Protein-based Nano-circuitry, DNA as functional template for Nano-circuitry.	**6Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	2	2	2	3	2	3	3	2	2	3	2	2	2
CO 2	2	2	3	2	2	2	1	2	2	3	3	2	3	2	3
CO 3	3	2	1	3	3	2	3	2	1	1	1	2	2	2	2
Average	**2.3**	**2.3**	**2.0**	**2.3**	**2.3**	**2.3**	**2.0**	**2.3**	**2.0**	**2.0**	**2.0**	**2.3**	**2.3**	**2.0**	**2.3**

References	1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley Publishers, April 2004.

	2. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education 3. Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008. 4. Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London,2007.

Course code	**BTMT-605**				
Category	**Engineering and Technology**				
Course title	**FOOD ENGINEERING AND QUALITY CONTROL**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course isto make aware the students about the quality control methods used in industry. The course is designed to teach students food processing concepts for and quality control principles				
Outcomes	1. Describe and outline the principles of food processing design and production techniques. 2. Collect and interpret the data from experiments in different food processing operations. 3. Analyse the quality parameters of food products from different food processing operations. 4. Generate a quality management system based on the Hazard Analysis Critical Control Point (HACCP) principles to food processing. 5. Identify and explain issues relevant to food processing and food quality management systems.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Quality factors:** appearance, texture and flavor, Apperance factors –				**6 Hrs**

	size and shape, colour ad gloss, consistency. Textural Factors measuring texture, texture changes.	
Unit-2	**Flavour Factors** – influence of colour and texture on flavor. Taste Panels. Food – related azards – biological hazards, chemical hazards, physical hazards, trace chemicals. Microbiological considerations in food safety.	**6Hrs**
Unit-3	Food additives – preservatives, antioxidants, sequestrants, surface active agents, stabilizers and thickeners, bleaching and maturing agents, starch modifies, buffers, acids, alkalis, food colours, artificial sweteners, nutritional additives, flavouring agents.	**6Hrs**
Unit-4	Food laws: Federal Food Drug and Cosmetic Act (1938), Good Manufacturing Practices (Code of GMP), Fair Packaging and Labeling Act (1966), Federal Meat Inspection Act (1906), International Food, Standards and Codex Alimentarius, HACCP and ISO 9000 series.	**6 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	3	2	2	1	2	1	1	2	2	3	3
CO 2	1	1	2	3	2	1	2	3	2	3	2	3	2	2	2
CO 3	3	3	2	2	2	2	3	-	3	2	2	3	2	2	2
CO 4	2	2	3	1	2	2	2	1	2	2	2	2	1	2	2
CO 5	3	2	2	3	1	1	3	2	1	1	1	2	2	2	2
Average	**2.2**	**2.0**	**2.2**	**2.0**	**2.0**	**1.6**	**2.4**	**1.8**	**2.0**	**1.8**	**1.6**	**2.4**	**1.8**	**2.2**	**2.2**

References

1. Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. Food Engineering Operations. Elsevier.
2. Charm SE, McCabe WL, Smith JC & Harriott P.1993.Unit Operations of Chemical Engineering. McGraw Hills.
3. Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
4. Fellows P. 1988. Food Processing Technology.
5. VCH Ellis Horwood. Heldman DR & Singh RP.1995. Food Process Engineering. AVI Publ.
6. McCabe WL & and Smith JC. 1971. Fundamental of Food Engineering. AVI Publ.
7. Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing Vikas Publ. House.
8. Singh RP & Heldman DR. 1993. Introduction to Food Engineering. Academic Press.