Department of
BIOTECHNOLOGY

4 Years B.Tech Degree Programme

REGULATION & SYLLABUS 2017

Choice Based Credit System
Outcome Based Assessment

SEMESTER-VII & VIII

AUTONOMOUS
Accredited by NBA
Accredited by NAAC with 'A' Grade (3.28 out of 4.00 CGPA)

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
Affiliated to UGC New Delhi &Biju Patnaik University of Technology, Odisha
GUNUPUR – 765022, Odisha, India

COURSE STRUCTURE

VII SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	QP
THEORY							
1	**BBTPC7010**	Bioreactor Design and Analysis	3	-	-	3	
2	**BBTPC7020**	Medical and Pharmaceutical Biotechnology	3	-	-	3	
3	**BBTPE7031**	Food Biotechnology	3	-	-	3	
	BBTPE7032	Bio Energy					
	BBTPE7033	Bio system Engineering					
	BBTPE7034	Animal Biotechnology					
4	**BBTPE7041**	Biomaterial	3	-	-	3	
	BBTPE7042	Stem Cell Engineering					
	BBTPE7043	Tissue Engineering					
	BBTPE7044	Nano biotechnology					
5	**OE3**	-------	3	-	-	3	
PRACTICAL / SESSIONAL							
6	**BBTPC7110**	Bioreactor Design and Analysis Lab	-	-	2	1	
7	**BBTPE7120**	MOOC subject*	-	-	2	2	
8	**BBTPC7130**	Mini Project	-	-	6	3	
9	**BBTPC7140**	Advanced lab – II	-	-	2	1	
10	**BBTPC7150**	Summer Internship	-	-	-	1	
Total						**23**	

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC7010	**Bioreactor Design and Analysis**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1:To understand the importance of bioprocess engineering and the role of bioprocess engineer and the importance of regulatory constraints.

CEO2:To understand the instrumentation and control of bioreactors their scale up aspects etc.

Course Outcome

CO1	Students will learn the principle and operation of different types of bioreactors.
CO2	The student wills understand the conditions for both ideal and non-ideal bioreactors.
CO3	The student will know about mass transfer in biochemical processes carried out in different bioreactors.
CO4	Students will acquire basic concept in bioreactor design and modeling and simulation of fermentation process.

UNIT:1 (12 Hours)

Principles and concepts: Recapitulation of the principles of Kinetics for chemical and Bio-chemical Reactions. Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air lift fermenteretc, stirred tank/mixed reactors, adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plantcell culture

UNIT:2 (14 Hours)

Bioreactor Analysis: Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Non-ideal Reactor. Concept of ideal and non-ideal reactor; residence time distribution;models of non-ideal reactors – plug flow reactor for microbial processes.

UNIT:3 (13 Hours)

Mass transfer in biochemical processes; Multiphase bioreactors – packed bed with immobilized enzymes or microbial cells; three – phase fluidized bed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

UNIT:4 (12 Hours)

Bioreactor Design: Design considerations: oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocess control and computer coupled bioreactors; Growth and product formation by recombinant cells. Mechanical fittings in a bioreactor: vessel, agitation system materials, piping and valves for biotechnology. Instrumentation and control of bioprocesses: Bioreactor sensor, online sensors for cell properties, off-line analytical methods; Biosensors. Bioreactor design calculation.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986. Press.
2. Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach

Ref. Books

1. Bailey &Olis, Biochemical Engg. Fudamentals, MGH.,1990
3. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
4. Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC7020	**Medical and Pharmaceutical Biotechnology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide knowledge on drug development and new generation antibiotics.

CEO2:To provide theory and practical knowledge on diagnosis technique.

Course Outcome

CO1	Students will understand the drug development in pharmaceutical process
CO2	Students will understand the recent disease and diagnosis and their therapy
CO3	Students will learn about the role of proteomics assay in drug development
CO4	Students will know about the control of different pharmaceutical products.

UNIT:1 (13 Hours)

Production of pharmaceuticals by genetically engineered cells (hormones, interferons), Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics), Techniques for development of new generation antibiotics. Protein engineering, drug design, drug targeting.

UNIT:2 (13 Hours)

ELISA and hybridoma technology, Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis, Diagnostic kit development for microanalysis, Genetic diseases and DNA based diagnoses, DNA vaccine, Gene Therapy, Toxicogenomics

UNIT:3 (11 Hours)

Role of Proteomics in Drug Development, Diagnosis of disease by Proteomics Development of antibody based protein assay for diagnosis.Separation and identification techniques for protein analysis, Development of antibody based protein array for diagnosis

UNIT:4 (8 Hours)

Pharmaceutical products and their control, Therapeutical categories such as laxatives, vitamins, analgesics, non-steroid contraceptives, antibodies and Biologicals Hormones.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Stanbury.P.F, Whitaker.A and Hall.S.J, "Principles of Fermentation Technology", 2nd Edition, Aditya Books (P) Ltd, 1995.
2. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl
3. Gary Walsh, "Pharmaceutical Biotechnology-Concepts and Applications," Wiley, 2007

Ref. Books

1. Epenetos A.A.(ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London
2. Text book of industrial pharmacy by S R Hiremath, Orient Black Swan publication.
3. Leon and Lachman et al- Theory and Practice of Industrial pharmacy.

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE7031	**Food Biotechnology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1:To provide knowledge on food production technology

CEO2: To have idea on food preservative technologies

Course Outcome

CO1	Students will understand the composition of major food products ,analysis of food quality and food production technology.
CO2	Students will understand the role of beneficial enzymes in food processing and preservation.
CO3	Students will understand the causes of food spoilage and technology used to control or destroy micro organism commonly found in food.
CO4	Students will understand the role of beneficial micro organisms in food processing and preservation.

UNIT:1 (10 Hours)

Food quality and Production technology Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Single cell protein, mushroom, Fermentative production of food, Pickling and alcoholic beverages, Genetically manipulated crop based food, oriental foods, probotics/ prebiotics in food products.

UNIT:2 (10 Hours)

Technology for improved process Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production, Utilization of food waste for production of value added products, enzymes in sugar syrup, genetically modified food.

UNIT:3 (14 Hours)

Food spoilage and control Spoilage of food, Microbiology of water, meat, milk, vegetables, Microbial safety of food products, Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation. Technology – canning, dehydration, ultrafiltration, sterilization, irradiation etc.

UNIT:4 (15 Hours)
Microbiology of fruits & vegetable and products like jam, jelly, sauce, juice; Microbiology of cereal and cereal products like bread, biscuits, confectionary. Microbiology of milk & milk products like cheese, butter, ice-cream, milk powder; Microbiology of meat, fish, poultry & egg and their products.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Food Biotechnology by V K. Joshi and R.S. Singh, I K International Publishing House. 2. Food Biotechnology by Rita Singh , Global vision publishing house
Ref. Books 1. Fundamental of food biotechnology by Byong H. Lee, Wiley-BCH. 2. Food biotechnology by S.C. Bhatia, WPI Publishing

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE7032	**Bio Energy**	**3**	**0**	**0**	**3**	
Pre -Requisite:						
Course Educational Objective						
CEO1: To provide the importance of energy of social development.						
CEO2: To provide knowledge on different kind of energy sources.						
Course Outcome						
CO1	Student will familiar with different types of biomass and there uses.					
CO2	Student will know about biogas and other biofuels.					
CO3	Student will know about bacterial sources of energy.					
CO4	The undergraduates have an idea about different types of renewable energy.					
CO5						

UNIT:1 (10 Hours)
Biological fuel generation: Biomass as a renewable energy source; types of biomass – forest, agricultural and animal residues, industrial and domestic organic wastes: classification, chemical composition and properties, conversion of biomass to clean fuels and petrochemical substitutes by physicochemical and / or fermentation processes. Dry and wet fermentation, digester for rural application(low rate and high rate)
UNIT:2 (10 Hours)
Sources of biomass; biogas from anaerobic digestion; thermal energy from biomass combustion ethanol from biomass., oil extraction and transesterfication of oils to produce biodesel Algae as source of fuel. Role of biotechnology in production of biofuels
UNIT:3 (15 Hours)
Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation; Microbial recovery of petroleum by biopolymers (Xanthium gum), bisurfactants. Thermal conversion(pyrolysis, gasification, reforming and combustion)
UNIT:4 (10 Hours)
Solar energy: solar collectors, solar pond, photovoltaic cells, chemical storage. Geothermal energy and wind energy: Use of geothermal energy, operating principles of different types of wind energy mills. Nuclear energy: nuclear reactions and power generating tidal wave

energy.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Biotechnology by B.D. Singh
2. Biotechnology by P K Gupta

Ref. Books

1. A text book of by S.K Jain
2. A text book by biotechnology by R.C. Dubey, S. Chand
3. A text book by biotechnology by H.K. Das, Willy India

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE7033	**Bio system Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: student will know a range of advanced design methods and be able to apply a structural design method to a typical biosystems engineering design problem;

CEO2: student will have some skill in recognizing and describing biosystems design problems;

Course Outcome

CO1	To be familiar with the theory on technology development and systems innovation and be able to apply this to a typical biosystems engineering design case
CO2	To have developed skill in redefining and redesigning a biosystem
CO3	To be able to evaluate and reflect on a design from a technical, biological and sustainability point of view
CO4	To have developed competence in functioning in and contributing to design teams

UNIT:1 (14 Hours)

Introduction to Biosystems Engineering : An introductory series of lectures will introduce students to various elements of the degree programme in Biosystems Engineering. The course will also include topics of current developments and case studies in the area. Essays in selected topics will be required.

UNIT:2 (15 Hours)

Introduction to Biosystems : Definitive properties and levels of organization of living systems. Chemical composition of living systems. Cell metabolism. Origin of life-metabolic evolution. Diversity of life forms. Animal and plant tissues and organs. Physiological systems. Protists. Nutrient requirements of organisms. Populations, communities and ecosystems. Biogeochemical cycles. Emergence of man. Impact of man on the biosphere.Social implications of recent advances in biology.

UNIT:3 (14 Hours)

Biosystems Modelling : Numerical and computer modeling of biological engineering processes including the drying of solid and liquid biomaterials.Numerical modeling systems using finite element and finite difference methods including practical examples as well as analytical solutions.

UNIT:4 (13 Hours)

Biosystems Engineering : Modes of heat transfer in biological materials. Heat exchangers. Mass balances, mass transfer. Separation processes including: distillation, filtration, membrane processes, centrifugation, chromatography. Reactor design, Psychrometrics in biological systems. Process laboratory.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books Biosystems Engineering I: Creating Superior Biocatalysts (Advances in Biochemical Engineering/Biotechnology Book 120) 10th Edition, Kindle Edition

Title of the subject

Subject Code		L	T	P	C	QP
BBTPE7034	**Animal Biotechnology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide a basic knowledge on animal cell culture.

CEO2: To provide the knowledge on application of cell culture for pharmaceutical purposes.

Course Outcome

CO1	Student will understand the basics of animal cell culture and culture conditions.
CO2	The students will acquire knowledge in optimization of media, scaling up animal cell culture, characterization and maintenance of cell lines.
CO3	Students will understand the stem cell culture and its applications in tissue engineering and animal cloning.
CO4	Students will learn molecular biology techniques like PCR, hybridization and RFLP.
CO5	

UNIT:1 (12 Hours)

Animal Biotechnology Equipments and materials for animal cell, culture technology, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Development of primary culture. Development of cell line by enzymatic disaggregation, Biology and characterization of the cultured cells, measuring parameters of growth

UNIT:2 (15 Hours)

Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application.Behavior of cells in culture, division, their growth pattern, metabolism of estimation of cell number. Measurement of viability and cytotoxicity; Scaling up the cell culture to large scale/industrial level production.Development of cell lines, characterization and maintenance of cell lines, cryopreservation, common cell culture contaminants. Culture of cells for production of various biologicals.

UNIT:3 (10 Hours)

Application of animal cell culture, stem cell cultures, embryonic stem cells and their applications. Hybridoma technology, Organ culture technology, Transfection of animal cells, Future tissue engineering, animal cloning.

UNIT:4 (10 Hours)

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, insitu hybridization; northern and southern blotting; RFLP.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Animal cell culture by R.I. Freshney
2. Animal Biotechnology by P.Ramadas

Ref. Books

1. In vitro cultivation of Animal cells by Dr.C.K.Leach,Butterworth and Heinnmamm Ltd.1994.
2. Hand book of Animal Husbandry by Gopalakrishnan .
3. A Text Book of Biotechnology R C Dubey, S Chand publication

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE7041	**Biomaterial**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide Knowledge on biomaterial and biomedical engineering.

CEO2: To provide knowledge on different types of composite materials.

Course Outcome

CO1	Students will able to Classify and understand the properties of biomaterials
CO2	Student will also acquire knowledge on various types of biomaterials and use of novel biomaterials in biomedical engineering.
CO3	Students will understand the concepts for developing new materials for tissue engineering and bio-implant applications.
CO4	Students will be able to know biocompatibility of materials using in vivo and in vitro techniques.
CO5	

UNIT:1 (10 Hours)

Introduction to biomaterials, Types and properties (mechanical, structural, thermal, optical, electrical and surface) of biomaterials, Synthetic polymer, Natural polymer.

UNIT:2 (12 Hours)

Novel Biomaterials and uses in Biomedical engineering: Hydrogels, self-assembling peptides. Implants materials: metallic implant materials, stainless steels, Co-based alloys, Ti- based alloys; ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons. Polymeric implant

UNIT:3 (14 Hours)

Polymers for drug delivery: types of polymer, pharmaceutical polymers, physicochemical properties of polymers and relationship with structure, properties, kinetics, mechanisms and applications. , Biomaterials for ophthalmology, orthopaedic and dental implants, Biologically functional biomaterials

UNIT:4 (14 Hours)

Biocompatibility and blood compatibility, Biomaterials: its foreign body response in a body. Biological interface, interaction with biomaterials and adhesion, Biological response to implants, 2D and 3D matrices (scaffolds) of biomaterials for tissue engineering, Soft tissue and hard tissue replacement, cardiovascular implants. Characterization techniques of biomaterials.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Buddy D. Ratner Allan S. Hoffman Frederick J. Schoen Jack E. Lemons. Biomaterials Science, Second Edition: Wiley Science 2004.
2. Bhatt SV, Biomaterial, Narosa publishing house

Ref. Books

1. Park J and R. S. Lakes R S, Biomaterials: An Introduction, Springer 2009

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE7042	**Stem Cell Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide basics of stem cell and its type.

CEO2: To know about importance and application of stem cells.

Course Outcome

CO1	Students will learn the concept of stem cells, different types of stem cells and their potential.
CO2	Students will acquire knowledge in applications of stem cells in tissue engineering and drug discovery.
CO3	Students will acquire idea about genetic engineering of stem cell and applications of stem cells in cloning.
CO4	Students will learn the therapeutic applications of stem cells.
CO5	

UNIT:1 (14 Hours)

Stem cell basics: Unique properties of stem cells, embryonic stem cells, adult stem cells, Umbilical cord stem cells, similarities and differences between embryonic and adult stem cells.Properties of stem cells, pluripotency, totipotency. Embryonic stem cell: In vitro fertilization, culturing of embryos-isolation of human embryonic stem cells, blastocyst, inner cell mass,growing ES cells in lab, laboratory tests to identify ES cells, stimulation ES cells fordifferentiation, properties of ES cells.

UNIT:2 (14 Hours)

Adult stem cells: Somatic stem cells, test for identification of adult stem cells, adult stem cell Differentiation, trans differentiation, plasticity, different types of adult stem cells. Stem cell

in drug discovery and tissue engineering: Target identification, Manipulating differentiation Pathways, stem cell therapy Vs cell protection, stem cell in cellular assays for screening stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescentprotein tagging, stem cell based drug discovery, drug screening and toxicology.

UNIT:3 (12 Hours)

Genetic engineering of stem cells: Gene therapy, genetically engineered stem cells, stem cells and animal cloning, transgenic animals and stem cells.Stem cell regulations, debate, social and ethical concerns.

UNIT:4 (12 Hours)

Therapeutic application of stem cells: Therapeutic applications Parkinson disease, Neurological disorder, limb amputation, heart disease, spinal cord injuries, diabetes, burns, HLA typing, Alzheimer's disease, tissue engineering application – production of complete organ, kidney, eyes, heart, and brain

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Embryonic Stem cells by Kursad and Turksen. 2002.Humana Press.
2. Hematopietic Stem Cell Transplantation by Treleaven, J., first edition 2009

Ref. Books 1. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press
2. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2008
3. Stem Cells: From Bench to Bedside by Bongso and Ariff BTBT903 Nanobi

Title of the subject

Subject Code		L	T	P	C	QP
BBTPE7043	**Tissue Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide basics of tissue engineering and its type.

CEO2: To know about importance and application of tissue engineering

Course Outcome

CO1	Under graduates should know about the importance and scope of tissue engineering.
CO2	Student will understand the structural organization of cells and tissues, the role of cell interaction, cell migration and cellular processes
CO3	Student will gain the knowledge about different biomaterials and its properties, design, fabrication and biomaterials and applications
CO4	Student will get the knowledge about stem cells and their role in tissue engineering

UNIT:1 (12 Hours)

Introduction to tissue engineering: Basic definition, current scope of development, use in therapeutics, cells as therapeutic agents, cell numbers and growth rates. Measurement of cell characteristics: morphology, number viability, motility and functions. Measurement o tissue characteristics: Appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT:2 (12 Hours)

Tissue types and tissue components, tissue repair, engineering wound healing and sequence of events. Basic wound healing applications of growth factors: VEGF/angiogenesis, basic properties, cell-matrix & cell-cell interactions, telomeres and self-renewal, control of cell migration in tissue engineering.

UNIT:3 (12 Hours)

Biomaterials: Properties of biomaterials, surface, bulk, mechanical and biological properties, scaffolds in tissue engineering. Types of biomaterials: biological and synthetic materials, Biopolymers. Applications of biomaterials, modifications of biomaterials. Role of Nanotechnology in tissue engineering.

UNIT:4 (15 Hours)

Stem Cells : Introduction, hematopoietic differentiation pathway. Potency and plasticity of stem cells,sources,embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Lanza RP, Robert Langer R and Chick WL, Principles of Tissue Engineering, Academic Press (1997)

1. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.

Ref. Books 1 Palsson B and Bhatia S. Tissue Engineering, Pearson-Prentice Hall, (2003)

2. Introduction to Biomedical Engg. , Endarle, Blanchard & Bronzino, Academic press.

3

Title of the subject

Subject Code		L	T	P	C	QP
BBTPE7044	**Nanobiotechnology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide the knowledge on importance on nano biotechnology and its application.

CEO2: To have an idea about the application of nano biotechnology in industry.

Course Outcome

CO1	Student will learn the concept of "nanotechnology" and its interdisciplinary aspects.
CO2	Students will learn various approaches of synthesizing nanomaterials, their advantages and limitations.
CO3	Students will gain knowledge about various techniques used for characterizing nanomaterials.
CO4	Students will understand the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications.
CO5	Students can evaluate the potential toxic effects of nanotechnology on living organisms and the environment.

UNIT:1 (10 Hours)

Basic Concepts of Nanoscience: Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, applications of nanotechnology, challenges and future prospects, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials

UNIT:2 (10 Hours)

Synthesis and Characterization of Nanomaterials: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition,

wet chemical synthesis of nanoparticles, self-assembled monolayer, Characterization of nanostructures, Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy.

UNIT:3 (10 Hours)

Engineered Nanomaterials for Biological Applications: Current status of nanobiotechnology, biogenic synthesis of nanoparticles: microbial and plant mediated, surface functionalization of nanomaterials, biological applications of functionalized nanomaterials, Biological nanomachines: ribosomes, photosynthesis systems, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and biopesticides delivery applications.

UNIT:4 (12 Hours)

Biomedical Applications and Nanotoxicity: Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, functionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.

2."Nanostructures and Nanomaterials: Synthesis, Properties and Applications", G. Cao, Imperial College Press (2004)

2. Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)

Ref. Books

1. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.

2. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.

1: Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.

Subject Code	**Course Title**	L	T	P	C	QP
BBTPC7110	Bioreactor Design and Analysis Lab	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid
Course Educational Objective
In this laboratory, students will have the opportunity to study about parts, operation and standardization of bioreactor
Study about the effect of various parameters on the growth of microorganisms in controlled bioreactor conditions.

Course outcomes: At the end of the course, the student will be able to:	
CO1	The student will study about the various parts and operation of bioreactor.
CO2	Effect of physical parameters on the growth of microorganisms.
CO3	The student will determine the oxygen transfer rate in bioreactor by folowing various methods.
CO4	The undergraduate will learn working of various bioreactors used in industries.

LIST OF EXPERIMENT

1. Bioreactor operation – Demonstration
2. Batch, fed batch and continuous cultures a) Estimation of Monod parameters b) Pure and mixed cultures.
3. Temperature effect on growth-estimation of energy of activation and Arrhenius constant for micro-organisms.
4. Determination of Oxygen transfer rate
   K_La determination by sulphite oxidation method
   K_La determination by dynamic gassing method
   K_La determination by power correlation analysis
5. Packed bed bioreactor: study of process parameters
6. Fluidised bed reactor: study of process parameters
7. Screening of process variables single dimensional search, Blackett Burman design, design expert etc.
8. Study of rheology of fermentation broth and power determination.
9. Bioprocess control using software
10. Production of secondary metabolites by feed batch culture.

COURSE STRUCTURE

VIII SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	QP
THEORY							
1	**BBTPE8011**	IPR, Bioethics and Bio safety	3	-	-	3	
	BBTPE8012	Bioprocess Optimization					
	BBTPE8013	Biofuel and Energy Technology					
2	**BBTPE8021**	Structural Biology	3	-	-	3	
	BBTPE8022	Protein Engineering					
	BBTPE8023	Biosensor and Diagnostics					
3	**OE4**	------	3	-	-	3	
PRACTICAL / SESSIONAL							
4	**BBTPC8110**	Comprehensive VIVA	-	-	4	2	
5	**BBTPC8120**	Seminar	-	-	4	2	
6	**BBTPC8130**	Major project/ Industrial project /Startup training cum project	-	-	12	6	
Total						**19**	

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE8011	**IPR, Bioethics and Bio safety**	**3**	**0**	**0**	**3**	

Pre -Requisite:	
Course Educational Objective	
CEO1: To provide the knowledge on importance on IPR in Biotechnology.	
CEO2:To introduce biosafety regulations and its application in biotechnology	
Course Outcome	
CO1	Student will understand the basics of intellectual property rights and its importance
CO2	Students will obtain knowledge in patent requirements; patent writing and patenting procedure.
CO3	Students will understand the professional responsibilities for biosafety, biosafety levels, international agreements and protocols for Biosafety.
CO4	Students will understand the social and ethical issues related to plant, animal and modern biotechnology.

UNIT:1 (12 Hours)

Concept of property, rights, duties and their correlation; Intellectual property rights and its types- Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

UNIT:2 (14 Hours)

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art; Patent databases; Searching International Databases; Analysis and report formation; Indian Patent Act 1970 and Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a patent, International patenting-requirement, Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neem etc.

UNIT:3 (12 Hours)

Introduction to Biosafety regulations; Primary Containment for Biohazards and Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India. Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs.

UNIT:4 (10 Hours)

Overview of National Regulations and relevant International Agreements including Cartagena Protocol. Concept of Bioethics, Public concerns on Human genome research and transgenics- Genetic testing and screening, Ethics in clinical trials and GCP, ELSI & Human genome projects; Ethics in human cloning-a case study.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Stanley SA, Bioethics, Wisdom educational services
2. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Title of the subject						
Subject Code		L	T	P	C	QP

BBTPE8013	**Biofuel and Energy Technology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To gain the knowledge about natural energy resources

CEO2:Build models that simulate sustainable and renewable green energy technology systems

Course Outcome

CO1	To gain the knowledge about natural energy resources
CO2	Build models that simulate sustainable and renewable green energy technology systems
CO3	Understand the history, global, environmental and economical impacts of green energy technology
CO4	To acquire the technical knowledge of biofuel production and its applications

UNIT:1 (10 Hours)

Energy: Introduction; Resources: Renewable and non-renewable resources (Water, Minerals, and Energy; Use and over exploitation; Classification and Sources of Energy ; Problems relating demand and supply of various energy sources; Coal, Petroleum etc.

UNIT:2 (12 Hours)

Biomass and Energy Crops: wood (Lignocellulose)–Degradation by microorganisms andpathway studies. Sugar and Starch crops-Degradation by microorganisms and pathway studies. Oil seeds crops-Degradation by microorganisms and pathway studies. Hydrocarbon producing crops-Degradation by microorganisms and pathway studies.

UNIT:3 (13 Hours)

Biofuels: First Generation Biofuels: Bioethanol ,–Production meachnisms by microbes,Second Generation Biofuels:Methane and Hydrogen–Production mechanismsby microbes, Factors affecting Biogas yields. Third Generation Biofuels: Biobutanol. Biodeselfromalgae. Definition, advantages of biodiesel, properties of biodiesel, Transesterification, biodiesel from microalgae, algae cultivation, types of photobioreactor, Indian perspective of biofuels.

UNIT:4 (10 Hours)

From Microbes to Megawatts–Microbial Fuel Cells-Types of Biological fuelcells–Working Principle-Applications of Biological Fuel cells. Biofilm-Theory and applications. Biosensor-Theory and Applications. Environmental Nanobiotechnology, design of bioreactor

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1 Samir K. Khanal, "Anaerobic Biotechnology for Bioenergy Production: Principles and Applications", Wiley-Blackwell Publishing, 2008

2.David M. Mousdale, "Biofuels: Biotechnology, Chemistry, and Sustainable Development "CRC Press, 2008.

3. Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.), "Biofuel Technologies Recent Developments", Springer, 2013

Title of the subject

Subject Code		L	T	P	C	QP
BBTPE8021	**Structural Biology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: Evaluate appropriate physical scale (length, force, time, energy, etc.) that is applicable Inliving systems.

CEO2: To study the bimolecular assemblies and its confirmations

Course Outcome

CO1	Student can evaluate the appropriate physical scale (length, force, time, energy, etc.) that is applicable in living systems.
CO2	The undergraduate will study the bimolecular assemblies and its confirmations
CO3	Student will know the biophysical techniques used in structural and functional analysis
CO4	Student will get the knowledge of experimental physical techniques and their mechanisms in biological systems.

UNIT:1 (10 Hours)

Life and its physical basis, length force and time scales in living systems, chemicalbonding and stability of molecules, forces and energies at nanometer scale: Intermolecular interactions,electrostatic screening, chemical composition ofliving systems

UNIT:2 (10 Hours)

Macromolecules and supramolcular assemblies: types of macromolecules and biological systems, molecular assemblies, membrane, ribosome, extracellular matrix, Chromatin. Chromosomal analysis.

UNIT:3 (12 Hours)

Macromolecular structural determination: Physical technique in proteins, nucleic acids and polysaccharides structure analysis- UV, IR, Fluorescence spectrophotmetry, NMR,ESR, Raman Spectroscopy and their application in Biomedical field. Structure determination by Crystallography and X-Ray Diffraction.

UNIT:4 (10 Hours)

Physical Techniques: Diffusion, Sedimentation, Osmosis, Viscosity, theirdefinition, factors Influencing them and their application in biology.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1 Crothers and Eisenberg: Physical chemistry application to life sciences , Benjamin Cummings, USA.

2.Biophysical techniques by Upadhyay and Upadhyay

3 The Cell by Cooper

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE8022	**Protein Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1:To provide importance and application of protein engineering.

CEO2: To have an idea about industrial important enzymes.

Course Outcome

CO1	Student will gain the knowledge about different forces acting on protein structure interactions and proein enginnering applications.
CO2	Student will know thermodynamic and chemical principle of proteins
CO3	Student will know the features, design principles and approaches of protein engineering with stabilization.
CO4	Student will know the biophysical techniques used in protein characterization.

UNIT:1 (12 Hours)

Overview of protein structure and its hierarchical architecture; Protein engineering – definition,applications; Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding andweakly polar interactions, hydrophobic effects. Structural features of protein, Ramachandranmap, Protein-protein, Protein-DNA, protein-ligand interactions. Protein structure-functionrelationship.

UNIT:2 (10 Hours)

Stability of Protein Structure: Laws of thermodynamics, heat, energy and work, chemical equilibrium flexibility, reversible folding and unfolding, pH titration, chemical denaturation, thermal denaturation, solvent perturbation and chemical modification.

UNIT:3 (11 Hours)

Features or characteristics of proteins that can be engineered- affinity and specificity; Experimental methods of protein engineering: Rational designing, Directed evolution like site directed mutagenesis, Module shuffling, Guided protein recombination, etc.; Computational Approaches to protein engineering. Mechanism of stabilization of proteins from psychrophilesand thermophiles vis-à-vis those from mesophiles; Protein and enzyme engineering case studies For its stability, specifity and affinity- Protease, Lipase and Lysozyme. Role of solvent.

UNIT:4 (10 Hours)

Characterization of proteins: NMR spectroscopy, crystallography, spectroscopic (UV-Vis, CD, IR,Florescence), calorimetric methods, Viscometry, Molecular sieve chromatography, Electrophoresis, EPR in protein structure and function analysis with example.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Edited by T E Creighton, Protein function. A practical approach, 2nd Edition, Oxforduniversity press.
2. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.
3. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press.
4. L. Alberghina, Protein Engineering for industrial biotechnology, Harwood Academic Publisher

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE8023	**Biosensor and Diagnostics**	**3**	**0**	**0**	**3**	
Pre -Requisite:						
Course Educational Objective						
CEO1: To Provide						
CEO2:						
Course Outcome						
CO1	Student will gain the knowledge about different biosensors and their principles					
CO2	Student will know the construction and mechanism of biosensor with their components					
CO3	Student will get the relationship of biosensors with biological systems					
CO4	Students will know the application of biosensor for different diagnosis process					

UNIT:1 (15 Hours)

Introduction to biosensors- principles and applications; Components of Biosensor- Biological, Biochemical, Electrochemical, Electronic; Immobilization as key to biosensor construction, Bioaffinity principle and biosensor.

UNIT:2 (15 Hours)

Biosensor diversification, Principle, construction and applications of Redox mediated (Amperometric& Potentiometric) biosensor, Field Effect transitor systems (FETs) based biosensor, Thermistor based biosensor, Piezoelectric biosensors, Conductimetric biosensor, Calorimetric biosensor &Optoelectric biosensors; Whole cell biosensor, Immunosensors & In-vivo Biosensors.

UNIT:3 (6 Hours)

Variations on the biological /biochemical component, Bioaffinity principles, whole cell biosensors

UNIT:4 (9 Hours)

Applications of Biosensors: Clinical Chemistry & diagnostics, Medicine and health care, Veterinary, Agriculture and food production, Food preservation & contamination, Environment and pollution monitoring.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Turner APF et al., Biosensors fundamentals & Applications, Oxford University Press.
2 Blum LJ &Coulet PR, Biosensor Principles & Applications, , Marcel & Decker
.
3 Ramsay G, Commercial Biosensor, John Willey & Son
4 Walker JM &Rapley R, Molecular Biology and Biotechnology, Panima publishers