INTEGRAL UNIVERSITY

DEPARTMENT OF BIOENGINEERING

PROGRAMME: M. Tech. Biotechnology

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO1: An ability to acquire in-depth theoretical and practical knowledge of biotechnology and the ability to apply the acquired knowledge to provide cost efficient solutions in Biotechnology.

PSO2: An ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.

PSO3: An ability to translate knowledge of Biotechnology to address environmental, intellectual, societal and ethical issues through case studies presented in the class.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PE01. An ability to apply fundamental knowledge related to pure sciences in an interdisciplinary manner for providing innovative solutions to need based problems for global impact.

PE02. An ability to critically analyze scientific data, draw objective conclusions and apply this knowledge for human welfare. Students should be able to demonstrate expertise and ethical perspective on areas related to Biotechnology.

PE03. An ability to gain domain knowledge and know-how for successful career in academia, industry and research. Promoting lifelong learning to meet the ever evolving professional demands by developing ethical, inter personal and team skills.

PROGRAM OUTCOMES (PO):

PO1- Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2- Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3- Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4- Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6- The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7- Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9- Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12- Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course: BIOCHEMISTRY

Course Code BE501

Course Objectives:

This course is designed to introduce the organic structure of living systems mainly dealing with biomolecules like carbohydrates, proteins, lipids, enzymes and their metabolism laying the foundation for other advanced courses like physiology, cell biology, molecular biology and metabolic engineering.

Course Outcomes: ***After completion of the course, a student will be able to achieve these outcomes***

COURSE OUTCOME (CO)	DESCRIPTION
CO1	The students will learn about the carbohydrate metabolism, and its regulation; understand how the body meets the carbohydrate requirements, and how the carbohydrate metabolism is essential for synthetic pathways of other biomolecules.
CO2	The students will learn about structure and metabolism of lipids, and proteins in body.
CO3	The students will understand about the mechanism and regulation of nucleotide synthesis and degradation.
CO4	The course will aid the students in understanding other courses such as cell and molecular biology, immunology. This course will also lay the foundation for other advanced courses like metabolic engineering and bioprocess engineering.

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3

CO1	**3**	**3**	**3**	**2**	**3**	**2**	**0**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**1**	**0**	**1**	**0**	**2**	**2**	**3**	**3**
CO3	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**1**	**0**	**1**	**0**	**2**	**2**	**2**	**3**
CO5	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**1**	**0**	**1**	**0**	**2**	**2**	**2**	**3**

Course: BIOANALYTICAL TECHNIQUES

Course Code: BE 502

Course Objectives:

The paper will help students to acquaint with basic instrumentation, principle and procedure of various sophisticated instruments like HPLC, FACS, GLC and NMR etc. This will enable the students to implement the use of these techniques in biological research and in discovering new products/compounds.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes.***

COURSE OUTCOME (CO)	DESCRIPTION
CO1	The paper will help students to acquaint with basic instrumentation, principle and procedure of various sophisticated instruments.
CO2	The students will get the theory and practical knowledge of various instruments and their practical applications.
CO3	Proficient to work on sophisticated instruments like HPLC, FACS, SDS-PAGE, GLC and NMR.
CO4	The students are able to implement the use of these instruments in biological research and in discovering new products/compounds.

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**1**	**2**	**3**	**3**	**2**

Course: MICROBIAL GENETICS AND TECHNOLOGY

Course Code: BE 503

Course Objectives: The course is designed to understand the basics of microbial growth, reproduction, methods of genetic exchange. It will also focus on the media design, modes of operation of fermenter for large scale biomass and product formation and industrial applications of microbes

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes.***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Apply the concept of microbial nutrition to design media, sterilization procedure for the growth of micro-organisms for industrial applications
CO2	Analyze kinetics of microbial growth in different culture system and evaluate the best one for scale up. In-depth evaluation of microbial growth processes by the use of structured models, Deindoerfer and Gaden's classification. Understand the concept of maintenance and role of endogenous metabolism
CO3	Understand the process involved in genetic exchange in prokaryotes and apply the techniques for genome mapping
CO4	Students would be able to isolate, maintain , preserve and genetically modify microorganisms for scale production of valuable products

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	1	3	3	2	1	0	0	0	3	3	3	
CO2	3	3	3	3	3	3	3	3	3	1	0	3	3	3	2
CO3	1	0	0		0	2	0	0	0	0	0	3	2	2	2
CO4	2	1	2	1		2	2	2	3	2	3	3	3	2	1

Course: CELL AND MOLECULAR BIOLOGY

Course Code: BE-504

Course Objectives: The objective of the course is learning and understanding the fundamentals of molecular biology and cellular signalling. The application of the course focuses on fundamental concepts and their implications on disease processes.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes.***

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Describe the general principles of gene organization and expression in both prokaryotic and eukaryotic organisms and replication of genome
CO2	Discuss the various levels of gene regulation and expression
CO3	Explain the basic pathways of protein function , folding and targeting
CO4	Relate properties of cancerous cells to mutational changes in gene function.
CO5	Relate different signal transduction pathways and cell cycle control with disease pathogenesis. Understanding of protein kinases as primary elements in signalling.

CO-PO/PSO MAP

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**0**	**0**	**3**	**3**	**3**	**1**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**2**

CO3	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**0**	**3**	**2**	**2**	**2**
CO4	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**3**	**3**	**3**	**1**

Course: BIOPROCESS ENGINEERING

Course Code: BE 505

Course Objectives: Students are made capable of designing protocols for industrial scale production of medicinally and commercially important metabolites. Students can develop better understanding and perform more efficiently in commercial as well as research areas associated with medical research, food processing, agriculture, pharmaceutical development, waste management, and numerous other fields of science and industry.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes.***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Students will be capable of doing calculations in bioprocess engineering by a systematic approach with well-defined methods and rules
CO2	Students will be able to apply mass and energy balances to calculate the concentration of different gases in the fermenter off-gas, amount of reactant used, amount of oxygen etc.

CO3	Fluid Mechanics plays a very vital role in Mechanical, Civil and Biotech Engineering. The study will help the students in predicting the nature of fluid and to develop a concept for many real time problems which helps in the new developments
CO4	Study of thermodynamic properties of fluid and heat and mass transfer operations will help the students to run the fermenter

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**

Course: BIOCHEMISTRY & MICROBIOLOGY LAB.

Course Code: BE-506

Course Objectives: The lab is designed to train the students in basic and some advanced techniques of Biochemistry like isolation, purification, and estimation of biomolecules. It also deals with microbial techniques of isolation, purification and maintenance of microbial cultures.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

CO1	Maintain and identify bacterial and fungal strains on the basis of different staining.
CO2	Characterise bacteria on the basis of biochemical tests and Growth standardization.
CO3	Purify and identify proteins and DNA on the basis of molecular weight by SDS-PAGE and agarose gel electrophoresis respectively.
CO4	Prepare extract of some phytochemicals and isolate them by thin layer chromatography and estimate carbohydrates, proteins and nucleic acid by spectrophotometric method

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**0**	**3**	**1**	**0**	**1**	**0**	**0**	**3**	**1**	**0**	**3**	**3**	**3**	**1**
CO2	**2**	**2**	**3**	**2**	**1**	**2**	**0**	**0**	**3**	**1**	**0**	**3**	**3**	**3**	**1**
CO3	**3**	**1**	**3**	**1**	**1**	**1**	**0**	**0**	**3**	**1**	**0**	**2**	**3**	**3**	**1**
CO4	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**0**	**2**	**3**	**3**	**2**

CO5	**3**	**3**	**3**	**1**	**2**	**1**	**1**	**1**	**3**	**1**	**0**	**2**	**3**	**3**	**2**

Course: FERMENTATION TECHNOLOGY

Course Code: BE-507

Course Objectives: The objectives of this course are to develop understanding of ideal and non-ideal bioreactors, introduce concepts of heterogeneous reaction system, develop understanding of strategies for scale-up of bioreactor, Built concepts of control and monitoring in bioreactors.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Analyze the performance of ideal bioreactors.
CO2	Understand the effect of catalyst porosity, size and fluid properties on rate of reactions controlled by mass transfer.
CO3	Determine internal and overall effectiveness factors for zero and first order reactions.
CO4	Identify suitable process instrumentation for monitoring and control of bioreactors.

CO5	Scale-up bioreactors on the basis of rule of thumbs.

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**1**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**0**	**0**	**0**	**1**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**0**	**0**	**0**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**1**	**3**	**3**	**3**

Course: DOWNSTREAM PROCESSING

Course Code: BE 508

Course Objectives: To impart to the students the knowledge of various separation and purification techniques and enable them to design these processes.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

CO 1	The students will learn the different recovery process their principles and methodology, how to retrieve the desirable product in bioprocess industries.
CO 2	The students will get proper knowledge about the purification of desirable product from crude with the help of different purification techniques and methods in industrial level.
CO 3	The students will learn the new and recent techniques used for bioseperation with their principle and mode of operation.
CO 4	The students will get proper knowledge about how to handle and treatment of wastes discarded by bio-industries, what are the techniques, reactors their mode of operation used for

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	2	1	2	0	0	0	0	1	3	2	2
CO2	3	2	2	2	2	1	2	1	0	0	0	1	3	2	1
CO3	1	2	3	2	2	2	1	0	1	0	0	1	1	2	1
CO4	3	2	3	3	2	3	3	2	1	1	1	2	3	2	3

Course: GENETIC ENGINEERING

Course Code: BE 509

Course Objectives: The course is designed to make the students understand the concept and basic steps in gene cloning, to acquaint them with various vectors and enzymes used in recombinant DNA technology, transformation and screening techniques. They will also be acquainted with modern techniques such as PCR technology, Real-Time PCR, Site-directed mutagenesis, Antisense RNA technology and RNA interference.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Learn about different enzymes used in genetic engineering for DNA manipulations.
CO2	To study different vectors and their characteristics
CO3	Transformation methods and their use in Genetic Engineering, creation of different gene libraries.
CO4	Using genetic engineering for mutagenesis, gene silencing, and amplification of DNA, conceptualizes DNA finger printing.
CO5	Analyzing the safety guidelines and public concerns for r-DNA technology and also Determine the selection parameters of r-DNA.

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**

CO1	**2**	**2**	**3**	**1**	**3**	**1**	**1**	**2**	**0**	**1**	**0**	**3**	**3**	**3**	**1**
CO2	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**1**	**0**	**1**	**0**	**3**	**3**	**3**	**1**
CO3	**1**	**1**	**2**	**1**	**3**	**1**	**2**	**2**	**0**	**1**	**0**	**2**	**3**	**3**	**1**
CO4	**1**	**1**	**1**	**1**	**3**	**1**	**3**	**3**	**0**	**1**	**0**	**2**	**3**	**3**	**3**
CO5	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**3**	**0**	**1**	**0**	**2**	**3**	**3**	**3**

Course: ENZYME ENGINEERING

Course Code: BE 510

Course Objectives: To enable the students with the know-how of designing enzymatic processes and reactors, understanding enzyme kinetics, understanding and designing immobilization process and the basics of

CO-PO/PSO MAP

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Gain knowledge about structure, properties of enzymes, enzyme types Understand the process of industrial enzyme production and applications in various sectors
CO2	Analyse the mathematical derivations to understand enzyme reaction kinetics and types of inhibition.
CO3	Apply engineering principles in understanding immobilized enzyme reactions
CO4	Evaluate and design different enzyme reactors and apply research based knowledge to design solutions for large scale applications.
CO5	Understand the concept of enzymatic reactions in organic media and evaluate applied research about enzymes and present the search of recent studies about enzymes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	**3**	**2**	**2**	**2**		**1**	**1**	**0**	**0**	**0**	**0**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**3**		**2**	**2**	**0**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**1**	**3**	**2**	**0**	**0**	**0**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**0**	**3**	**3**	**3**	**2**

Course: FERMENTATION TECHNOLGY AND GENETIC ENGINEERING LAB

Course Code: BE 511

Course Objectives: The lab is designed to train the students to use the microbial cells/ culture for fermentative production of valuable products at the lab scale as well as industrial scale and also use the molecular biology techniques for advanced genetic engineering practicals.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

CO1	Perform Immobilization of whole cells and enzymes.
CO2	Demonstrate the Fermentative production of Organic acid/ alcohol/ enzyme. Design experiment for scale-up of fermentation parameters
CO3	Ability to isolate plasmid/ phage and plant/ animal (genomic) DNA, quantify and visualize DNA on gels, amplify DNA (using PCR). Demonstrate the use of various molecular markers to study biodiversity.
CO4	Prepare Competent cells and carry out experiments related to transformation, ligation and screening of transformants.
CO5	Demonstrate Blotting Techniques like Southern/ Northern/ Western Blot Techniques and apply them in various sectors of Biotechnology.

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	0	3	1	0	1	0	0	3	1	0	3	3	3	1
CO2	2	2	3	2	3	2	0	0	3	1	0	3	3	3	1
CO3	3	1	3	1	3	1	0	0	3	1	0	2	3	3	1
CO4	3	3	3	1	3	1	1	1	3	1	0	2	3	3	2
CO5	3	3	3	1	2	1	1	1	3	1	0	2	3	3	2

Course: NANOBIOTECHOLOGY

Course Code: BE 512

Course Objectives: Use knowledge of nano science and mathematics to follow protocols, conduct science or engineering procedures, fabricate products, make conclusions about results, troubleshoot, discover and independently seek out innovations in the rapidly changing field of nano-technology. Compile and analyze data and draw conclusions at the nano level.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

CO 1	The students are equipped with interdisciplinary knowledge of physics, chemistry and biology in the field of nanotechnology at a single platform. The students will acquire the knowledge of synthesis and characterization of nanomaterials for its various applications in the field of biological sciences. .
CO 2	Develops the understanding of utilizing biomolecules for designing tools and equipment (diagnostic tool, biosensors, smart drug delivery systems) for various applications in food, medicine and health science.
CO 3	Develops the ability to incorporate nanotechnology in the existing technology for developing different drug delivery systems like aerosol, inhalants, injectables etc.
CO 4	The also aware about the potential risks and ethical regulations associated with the emerging technology before their real-world application.

CO-PO/PSO MAP

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**3**	**3**	**3**	**2**
CO2	**2**	**2**	**3**	**1**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**3**	**3**	**3**	**2**
CO3	**2**	**3**	**3**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**0**	**2**	**2**	**2**	**2**
CO4	**1**	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**0**	**0**	**0**	**3**	**1**	**1**	**3**

Course: PLANT CELL TECHNOLOGY

Course Code: BE 513

Course Objectives: The objective of the course is to make students aware of the basic concepts of plant tissue culture. It deals with the initiation and maintenance of different types of cultures and genetic engineering techniques. The concepts of molecular markers and their applications are also being taught.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

CO 1	Give an account of the nutritional components of a plant tissue culture media. Discuss the concept of totipotency and regeneration of plants by micropropagation via organogenesis and somatic embryogenesis.
CO 2	Write note on types and applications of different cultures: callus, suspension, meristem, protoplast, anther, pollen and ovule. Discuss in vitro production of secondary metabolites by plant cell cultures using different techniques.

CO 3	Describe biological and physical methods of genetic transformation for the production of transgenic plants and discuss the social, moral and ethical considerations with respect to safety of genetic engineering.
CO 4	Write about different types of molecular markers and their applications.

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	**1**	**2**	**2**	**2**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**3**	**2**	**2**	**2**
CO2	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**2**	**3**	**2**	**3**
CO3	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**1**	**0**	**0**	**2**	**2**	**2**	**3**
CO4	**2**	**3**	**2**	**2**	**3**	**1**	**2**	**3**	**2**	**2**	**0**	**2**	**3**	**2**	**2**

Course: PHARMACEUTICAL BIOTECHNOLOGY

COURSE CODE: BE 514

Course Objectives: To equip students with the know-how of various pharmaceutical products and processes, and also with the applications of biotechnology in the pharmaceutical sector.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Describe the general principles of drug development and enhance learning of economic and regulatory guidelines related to pharmaceutical biotechnology.
CO2	Discuss the various aspects of drug action, metabolism and pharmacokinetics.
CO3	Explain the rationale behind drug design and types of chemotherapeutics viz., chemotherapy for infectious diseases and cancer.
CO4	Discuss the importance of Biopharmaceuticals and drug interactions vis a vis safety and efficacy of the drug.
CO5	Understand the principles of drug manufacture and preparation of various formulations. Awareness about GMP guidelines and usage of Analytical methods and other tests used in drug manufacture and quality management of Drugs.

CO-PO/PSO MAP

	PO I	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**2**	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**0**	**2**	**3**	**3**	**3**

CO2	**1**	**1**	**2**	**3**	**2**	**3**	**1**	**1**	**1**	**1**	**0**	**2**	**2**	**3**	**3**
CO3	**2**	**2**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**0**	**3**	**3**	**3**	**3**
CO4	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**0**	**3**	**2**	**3**	**3**
CO 5	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**0**	**3**	**2**	**3**	**3**

Course: BIOREACTOR ENGINEERING

Course Code: BE-515

Course Objectives: The objective of the course is to develop the concepts of ideal and non-ideal bioreactor design, residence time distribution in ideal and non-ideal bioreactors.

Course Outcomes (CO): ***After completion of the course, a student will be able to achieve these outcomes***

COURSE OUTCOME (CO)	**DESCRIPTION**
CO1	Compare the performance of ideal and non-ideal reactors using E- and F-curves

CO2	Determine the mean residence time and standard deviation using residence time distribution (RTD) data
CO3	Determine internal and overall effectiveness factors for zero and first order reactions.
CO4	Analyze the performance of non-ideal reactors using segregation model, tanks-in series model and dispersion model
CO5	Design equipment to maintain sterility in biochemical reactors.
CO6	Understand cost estimation process biochemical reactors

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C O1	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
C O2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
C O3	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
C O4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
C O5	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**3**	**2**
C O6	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**1**	**0**	**0**	**2**	**2**	**3**	**3**	**2**

Course: APPLIED MICROBIOLOGY AND BIOTECHNOLOGY

Course Code: BE 516

COURSE OBJECTIVES: The course helps in recollecting some basic but very important concepts in microbiology and biotechnology with advanced knowledge of various recent developments at industrial level in microbiology and biotechnology.

CO1	Gain knowledge about the detailed structure and genetic system of viruses and bacteria, Actinomycetes, fungi, Cyanobacteria and algae and criteria used in the classification of microorganisms based on morphology, cytology, genetics, host specialization, serology.
CO2	By gaining the knowledge of microbial production of bioplastics (PHB, PHA), bioinsectides (thuricide), biopolymer (dextran, alginate, Xanthan, pullulan), Biofertilizers (Nitrogen fixer/Phosphate Solubilizers/siderophore producers), Single Cell Protein, students may get an idea to develop their own ventures and become entrepreneurs.
CO3	Gain insights of medical biotechnology; Antibiotics and synthetic antimicrobial agents, Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Bacterial resistance to antibiotics. Microbial contamination and spoilage of pharmaceutical products, Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.
CO4	A brief idea about the products obtained from microbes, biology of industrial microorganisms such as Streptomyces, yeasts, *Spirulina* and *Penicillium*, Basic principle of fermentation technology, Overview of fermenter design, factors governing the chemical and biological aspects in a bioreactor,

	commercial production of penicillin, ethanol, vinegar, vitamin B12, Protease, citric acid and glutamic acid from microbial sources–production of commercially useful non-microbial products produced through recombinant microbes.

CO-PO/PSO MAP

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	**1**	**1**	**1**	**3**	**2**	**2**	**1**	**2**	**0**	**1**	**0**	**2**	**2**	**3**	**3**
CO2	**2**	**1**	**1**	**1**	**3**	**1**	**1**	**2**	**0**	**1**	**0**	**1**	**2**	**2**	**3**
CO3	**3**	**2**	**1**	**2**	**3**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**3**	**3**	**3**
CO4	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**0**	**1**	**0**	**3**	**3**	**3**	**2**

M Tech Biotechnology II Year

Bioinformatics, Genomics & Proteomics

BE – 601

COURSE OBJECTIVES: The objective of the course is learning and understanding the detailed developments and applications of the field of Bioinformatics in varied area of biological research. The course generally focuses on genomics, proteomics and computational biology studies and their relevance on research platform.

Course Outcomes: After completion of the course, a student will be able to achieve these outcomes

S No.	CO description
CO 1	Given a single biological sequence as an input, would be able to perform its pairwise alignment with a template sequence or its pairwise similarity searching with the list of sequences present in a reference database.
CO 2	Given an input protein sequence, would be able to predict its secondary & tertiary structure data.
CO 3	Given a protein and ligand molecule, would be able to draw out its various physiological, molecular and clinical level of interaction data in a pipeline manner, as an important part of modern drug designing approaches.
CO 4	Given an input nucleotide sequence would be able to predict its genetic sequence.

CO 5	For a list of available biological sequences would be able to perform its multiple sequence alignment studies and draw out its phylogenetic relationship.
CO 6	For a particular species of interest, would be able to draw out its structural and functional genomics data.
CO 7	Given an input protein sequence, draw out its proteomic s related data involving its structural, functional and protein –protein interactional data from the various available online resources.

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1	2	3	3	2	2	1	1	1	2	2	1	2	3	1	3
CO2	2	3	3	2	2	1	1	1	2	2	1	2	3	3	2
CO3	2	3	3	3	3	1	1	1	1	2	1	3	3	2	2
CO4	2	2	2	2	2	1	1	1	2	2	1	1	2	1	1
CO5	2	2	2	2	2	1	1	1	1	2	1	1	2	2	1
CO6	3	2	1	1	3	2	1	1	1	2	2	2	3	3	2
CO7	2	3	2	2	3	1	1	1	1	2	1	2	2	2	2

Course: Immunotechnology

Course Code: BE-602

Objective: The objective of the course is to apprise the students about components associated with immune system and molecular mechanism of their working. The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders.

Course outcomes (CO):

COURSE OUTCOME (CO)	DESCRIPTION
CO1	The student will be able to describe the fundamental principles of immune response including molecular, biochemical and cellular basis of immune homeostasis.
CO2	Describe the various aspects of immunological response and how its triggered and regulated
CO3	Understand the rationale behind various assays used in immunodiagnosis of diseases and will be able to transfer knowledge of immunology in clinical perspective.
CO4	Explain the principles of Graft rejection, Auto immunity and antibody based therapy.
CO5	Demonstrate a capacity for problem-solving about immune responsiveness, knowledge of the pathogenesis of diseases and designing of immunology based interventions for effective treatment.

CO-PO/PSO Map

PO	PO												PSO		
CO	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	3	3	3	2	1	1	2	2	2	3	3	3
CO2	1	1	2	3	2	3	1	1	1	1	1	2	2	3	3
CO3	2	2	1	3	3	3	1	1	2	2	3	3	3	3	3
CO4	1	2	3	3	3	3	2	3	2	2	3	3	2	3	3
CO5	1	2	3	3	3	3	2	3	2	2	3	3	2	3	3

Course: Animal Cell Engineering

Course Code: BE – 605

Objective: The course will help students to understand mechanisms of gene manipulation of animal cells, stem cell therapeutics and other frontier areas associated with molecular medicine.

COURSE OUTCOMES (CO):

CO1	The student will be able to describe the vast potential of animal biotechnology to eliminate or control many diseases and improve the health of animals and humans.
CO2	Relate the basic principles of biotechnology by application of genetics and techniques of molecular biology to animals for providing new medical services *viz.* stem cell therapy, gene therapy, vaccines, transplants, transgenic, organotypic cultures etc.
CO3	Describe the understanding of impact of engineering solutions on the society and also show awareness of contemporary issues of ethical and regulatory bodies exhibited by the biosafety risk associated with GMO construction in mammalian models.
CO4	Understand the technical aspects of existing technologies that will help them to address the complex medical challenges by applying their knowledge for the welfare of humankind.

CO-PO/PSO Map

PO	**PO**												**PSO**		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**2**	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**3**	**3**
CO2	**1**	**1**	**2**	**3**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**3**

CO3	**2**	**1**	**1**	**2**	**2**	**3**	**1**	**3**	**2**	**1**	**3**	**3**	**3**	**3**	**3**
CO4	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**

Course: Medical Biotechnology

Course Code: BE 612

Objective: The course will acquaint the students with pathogenesis and management of different diseases.

COURSE OUTCOMES (CO):

CO1	The student will be able to describe the genetic basis of disease and role of chromosomal aberrations in genetic disorders.
CO2	Relate the basic principles of Pathogenic mutations and Dynamic Mutations, basis of treatment with chemotherapeutic drugs and the mechanisms of drug resistance. The student will be able to learn about alternate systems of medicine.
CO3	Describe the understanding of pathogenesis, clinical conditions, laboratory diagnosis, epidemiology, chemotherapy and prevention of the viral,bacterial and fungal diseases. The student will also be able to learn about factors that influence Nosocomial infections
CO4	Understand the technical aspects of existing techniques in laboratory diagnosis that will help them to address the complex medical challenges by applying their knowledge for the welfare of humankind.

CO-PO/PSO Map

PO	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**2**	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**
CO2	**1**	**1**	**2**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**3**
CO3	**1**	**2**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO4	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**

Course name: Colloquium

Course Code: BE603

Course Objectives: To acquaint the student with the various techniques used in contemporary research that will be useful in successful completion of their project work in the final year.

Course Outcomes (CO): After completion of the course, a student will be able to achieve these outcomes

Course Outcome (CO)	**Description**
CO1	Perform scientific literature survey for a given research topic.

CO2	Identify research gap based on the literature survey.
CO3	Define a research problem, design the methodology to solve the said problem and analyze the solution.
CO4	Understand the ethics in conducting research.
CO5	Write a report on the research work in a proper format.

CO-PO/PSO map

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1					3	3			3		2	2	3	3	3
CO2		2	2	3	2	3			2			2	3	3	3
CO3		3	3	3	3	3			3		3	3	3	3	3
CO4						3		3				3	3	3	3
CO5			2	2	3	3		2	2	3	3	3	3	3	3

Course name: ADVANCES IN MOLECULAR TECHNIQUES

Course Code: BE 604

Course Outcome (CO)

Course Outcome (CO)	**Description**
CO1	The students will learn different techniques of DNA amplification, their principle and applications.
CO2	The students will understand the application of gene therapy by the use of gene silencing technique
CO3	The students will learn about the different DNA sequencing techniques, there principle, method, result interpretation and applications.
CO4	To make students understand about the importance and use of Molecular markers and techniques in molecular biology and biotechnology to identify a particular sequence of DNA in a pool of unknown DNA

CO-PO/PSO map

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1	**3**	**2**	**2**	**1**	**2**		**2**					**1**	**3**	**2**	**2**
CO2	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**1**				**1**	**3**	**2**	
CO3	**1**	**2**	**3**	**2**	**3**	**2**	**1**					**1**	**1**	**2**	**1**
CO4	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**1**			**2**	**1**	**2**	**3**

Course name: Biochemical Reaction Engineering

Course Code: BE606

Course Objectives: The objectives of this course are to develop the understanding of reaction kinetics in biochemical reactions. The students will be introduced to the concepts of different bioreactor designs, concept of residence time distribution, conversion and sizing. To introduce the students with the concepts of reactor modelling and mass transfer in bioreactors.

Course Outcomes (CO): After completion of the course, a student will be able to achieve these outcomes

Course Outcome (CO)	**Description**
CO1	Analyze the size isothermal reactors for homogeneous reactions for the given order of reactions.
CO2	Analyze multiple reactions (parallel and series) carried out isothermally and choose the reactor based on selectivity.
CO3	Determine the reaction order and specific reaction rate from experimental data.
CO4	Determine the mean residence time and standard deviation using residence time distribution (RTD) data
CO5	Compare the performance of ideal and non-ideal reactors using E- and F-curves
CO6	Understand the different factors affecting the oxygen mass transfer in bioreactors.

CO-PO/PSO map

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1	3	3	3	3	1	1						2	3	3	3
CO2	3	3	3	3	2	1						2	3	3	2
CO3	3	3	3	3	1	1						2	3	3	3
CO4	3	3	3	3	2	1						2	3	3	3
CO5	3	3	3	3	1	1						2	3	3	3
CO6	3	3	3	2		1						2	3	3	3