Course Structure for MSc (2 year)/ MSc + PhD Dual Degree Program in Biotechnology from AY 2025-2026

1st Year: Semester-I

Course Code	Course Title	Contact Hours (L-T-P)	Credits
BSE 633N	Basics of Physics, Chemistry and Mathematics	2-1-0	3
BSE 621N	Cell and Molecular Biology	2-1-0	3
BSE 611N	Biochemistry	2-1-0	3
BSE 609N	Microbiology	2-1-0	3
BSE 629	Genetics	2-0-0	2
BSE 6XX	**BSBE Flexicore I**	2-1-0	3
BSE 651N	Biochemistry Laboratory	0-0-4	2
BSE 659N	Microbiology Laboratory	0-0-4	2
Total minimum credits earned during the semester		**12-5-8=25**	**21**
Additional course (as per the requirement basis)			
HS 641	English Communication		P/NP

BSBE Flexicore I			
Course Code	**Course Title**	**Contact Hours (L-T-P)**	**Credits**
BSE 625	Emerging Technology	2-1-0	3
BSE 614	General Physiology	2-1-0	3

1st Year: Semester-II

Course code	Course Title	Contact Hours (L-T-P)	Credits
BSE 6XX	Bioprocess Engineering and Technology	2-1-0	3
BSE 6XX	Plant and Animal Biotechnology	2-1-0	3
BSE 618	Bioinformatics	2-0-2	3
BSE 702	Applied Genetic Engineering	2-1-0	3
BSE 6XX	**BSBE Flexicore II**	2-1-0	3
BSE 6XX	Scientific Communication Skills	0-2-0	2
BSE 654	Genetic Engineering Laboratory	0-0-4	2
BSE 6XX	Bioprocess Engineering and Technology Laboratory	0-0-4	2
BSE 6XX	Plant and Animal Biotechnology Laboratory	0-0-4	2
BSE 6XX	Research Ethics and Research Methodology		P/NP
Total minimum credits earned during the semester		**10-6-14=30**	**23**

BSBE Flexicore II			
Course Code	**Course Title**	**Contact Hours (L-T-P)**	**Credits**
BSE 608	Advanced Drug Delivery Systems	2-1-0	3
BSE 628	Genomics and Proteomics	2-1-0	3

2nd Year: Semester–III

Course code	**Course Title**	**Contact Hours (L-T-P)**	**Credits**
BSE 6XX (612)	Immunology and Immuno-technology	2-1-0	3
BSE 622	Molecular Diagnostics	2-0-0	2
BSE XXX	**Elective – I (Department)**	2-1-0	3
BSE XXX	**Elective – II (Department)**	2-1-0	3
ZZ XXX	**Elective – III (Institute)**	2-1-0	3
BSE 6XX	Immunology Laboratory	0-0-4	2
BSE 8XX	M.Sc. Project (Stage-I)	0-0-6	3
Total minimum credits to be earned during the semester		**10-4-10=24**	**19**

2nd Year: Semester-IV

Course code	**Course Title**	**Contact Hours (L-T-P)**	**Credits**
BSE 8XX	M.Sc. Project (Stage–II)	0-0-30	15
Total minimum credits to be earned during the semester		**0-0-30=30**	**15**
Total minimum credits to be earned during the program		**32-15-62=109**	**78**

Courses for Elective – I, II and III

Basket 1 (Any 3 courses) Infectious Biology			
Course Code	**Course Title**	**Contact hours (L-T-P)**	**Credits**
BSE 601	Advanced Molecular Biology	2-1-0	3
BSE 442/642	Fundamentals of Neuroscience	2-1-0	3
BSE 616	Infectious Diseases and Medical Microbiology	2-1-0	3
BSE 639	Tissue Engineering and Regenerative Medicine	2-1-0	3
ZZ XXX	Institute Elective	2-1-0	3

Basket 2 (Any 3 courses) Drug Discovery			
Course Code	**Course Title**	**Contact hours (L-T-P)**	**Credits**
BSE 605	Molecular Biophysics	2-1-0	3
BSE 417/617	Biomolecular Modelling	2-1-0	3
BSE 645	Drug Discovery, Design and Development	2-1-0	3
BSE 631	Bio-entrepreneurship IPR, Biosafety and Bioethics	2-1-0	3
ZZ XXX	Institute Elective	2-1-0	3

1st Year: Semester-I

Course Code	**BSE 633N**
Title of the Course	**Basics of Physics, Chemistry and Mathematics**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objective of this course is to give conceptual exposure of the essential contents of mathematics and statistics to students.
Course Outcome	On completion of this course, students should be able to: ● Gain broad understanding in mathematics and statistics; ● Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines. ● Have a firm foundation in fundamentals and application of current chemical and physical theories in biotechnology.
Course Syllabus	**Basic physics for biologists**: Newton's law of motions; simple harmonic motions, diffusion, dissipation, random walks, and directed motions in biological systems; low Reynolds number - world of Biology, buoyant forces, Bernoulli's equation, viscosity, turbulence, surface tension, adhesion; laws of thermodynamics: Maxwell Boltzmann distribution, and free energy, Maxwell's demon (entropic forces at work in biology, Coulomb's law, conductors and insulators, electric potential energy of charges, nerve impulses, voltage gated channels, ionic conductance; **Basic chemistry for biologists**: chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, Arrhenious equation, kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action etc.; chemical thermodynamics - Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation- reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials, electron transport chains (ETC) in biology, coupling of oxidative phosphorylations to ETC; **Mathematical Models in Biology:** Introduction to Differential and Integral calculus. Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks. **Statistics and Probability:** Probability; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.
Suggested Books	Text Books: 1. Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY: Palgrave Macmillan. (ISBN-10 : 0230579078, ISBN-13 : 978-0230579071) 2. Halliday, D., Resnick, R., & Walker, J. (1993). Fundamentals of Physics. New York: Wiley. (ISBN-10 : 9781118230718, ISBN-13 : 978- 1118230718) 3. Aitken, M., Broadhursts, B., & Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science. (ISBN-10 : 0815341369, ISBN- 13 : 978-0815341369) 4. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press. (ISBN-10 : 0538733497, ISBN-13 : 978-0538733496) Reference Books: 5. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New

	York: Wiley. (ISBN-10 : 1119282373, ISBN-13 : 978-1119282372) 6. Baaquie, B. E. (2000). Laws of Physics: a Primer. Singapore: National University of Singapore. (ISBN: N.A.) 7. Cantor, C. R., & Schimmel, P. R. (2004). Biophysical Chemistry. San Francisco: W.H. Freeman. (ISBN-10 : 0716710420, ISBN-13 : 978- 0716710424)

Course Code	**BSE 621N**
Title of the Course	**Cell and Molecular Biology**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Prerequisite, if any	None
Course Objective	The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.
Course Outcome	Upon successful completion of the course, students will be able to: ● Exhibit a fundamental understanding of cell structure, organization, and division, as well as cellular control by genetic material and various techniques used in cell and molecular biology investigations. ● Demonstrate both a basic understanding and practical competence in research methods related to cell and molecular biology, along with problem-solving skills.
Course Syllabus	**Dynamic organization of cell**- Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles. **Chromatin structure and dynamics**- Chromatin organization - histone and DNA interactome: DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control; breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery; genetic codes; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation. **Cellular signalling, transport and trafficking**– Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. **Cellular processes**- Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans- membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation. **Manipulating and studying cells**- Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins. **Genome instability and cell transformation**- Mutations, proto- oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations;

	suppression; transpositions- transposable genetic elements, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.
Suggested Books	Text Books: 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. (ISBN 978-0-8153- 4105-5) 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. (ISBN-13: 978-1464183393) 3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E.S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning. (ISBN-13: 9789380853710) Reference Books: 4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM; Sunderland. (ISBN-10:1605358630, ISBN-13: 9781605358635) 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings. (ISBN: 1292177691, 9781292177694) Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings. (ISBN- 10: 9332585474, ISBN-13: 978-9332585478)

Course Code	**BSE 611N**
Title of the Course	**Biochemistry**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.
Course Outcome	Through this course, students will be able to understand principles of biochemistry including enzyme kinetics and various metabolic pathways connecting with different disease pathologies.
Course Syllabus	**Chemical basis of life:** Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies. **Protein structure:** amino acids, types of protein structures, Ramachandran plot, evolution of protein structure, protein degradation and it's regulation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation. **Enzyme kinetics-Enzyme catalysis:** general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; catalytic antibodies; catalytic strategies; regulatory strategies with specific

	example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens. **Glycobiology:** Sugars and glycogen, amylase and cellulose, glycoproteins and glycolipids; lipids - structure and properties of storage and membrane, lipids; lipoproteins. **Structure and functions of DNA & RNA and lipids:** Self-assembly of lipids, micelle, bio membrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material. **Bioenergetics:** Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; ETS; Photosynthesis and mechanism, proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation. Role of vitamins & cofactors in metabolism; principles of metabolic regulation; steps for regulation.
Suggested Books	Text Books: 1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman. (ISBN-10: 1464126100, ISBN-13 : 978-1464126109) 2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth. (ISBN-10 : 9781319108243, ISBN-13 : 978-1319108243) Reference Books: 3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons. (ISBN: 978-1-118-91840-1)

Course Code	**BSE 609N**
Title of the course	**Microbiology**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objectives	The course will cover the fundamental of Microbiology. Students should be able to: ● Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity; ● Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms; ● Identify and demonstrate how to control microbial growth; ● Demonstrate and evaluate interactions between microbes, hosts and environment
Course Outcome	Upon successful completion of this course the students will be able to: ● To apply the knowledge to understand the microbial physiology and to identify the microorganisms. ● Understand the fundamentals of microbiology. ● To apply aseptic techniques for the isolation and culture of microorganisms. ● Characterization and identification of microorganisms: ● Understand the basic microbial structure and functions of various physiological groups of prokaryotes and eukaryotes
Course Syllabus	**History and Microbial Diversity** The historical foundations and development of microbiology; An overview of microbial world; Microbial diversity - Prokaryotic and eukaryotic microbial diversity; The bacteria and the archaea; Principles of bacterial taxonomy; Molecular methods in taxonomy; Intraspecies classification of bacteria. Morphology and structure of bacteria; Surface structures and inclusions of bacteria; Viruses- unique properties, morphology and structure; Virion, Viroids and Prions; Viral replication. Viral diversity –bacterial, plant and animal viruses; Fungi –properties and classification. **Microbial Growth and Culturing** Factors influencing microbial growth. Environmental and nutritional factors; Nutritional types of bacteria; Microbial locomotion – flagellar motility, gliding motility and amoeboid motion; Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria-culture media and methods; Measurement of bacterial growth. Bacterial growth curve; Binary fission, Growth cycle, Microbial growth at different temperature, pH and oxygen level; Continuous cultures; Maintenance and transport of cultures. **Identification of bacteria and Sterilisation methods** Identification of bacteria. Staining reactions; Cultural, physiological and biochemical characteristics; Sterilisation – Principles and methods, physical and chemical methods; Disinfectants – modes of action; Testing of disinfectants; Antibiotics – mechanism of action; Drug resistance in bacteria; Antibiotic sensitivity tests. **Microbial genetics** Genetic materials in bacteria; Bacterial chromosome; Extrachromosomal genetic elements; Plasmid, Transposons; Mutation, DNA repair, Mutant selection; Mechanism of gene transfer – transformation, transduction and conjugation. **Microbial metabolism** Microbial metabolism; Central pathways, Glycolysis, Pentose phosphate pathway, Entner Doudoroff pathway, TCA cycles, Electron transport chain, Aerobic and anaerobic respiration; Fermentation. Anaplerotic reaction; Peptidogycan synthesis, Bacterial photosynthesis.

Suggested Books	Text Books: 1. A. D. Russel et al., Principles and practice of disinsfection, preservation and sterilization, 5th ed., Wiley-Blackwell, 2013, ISBN-10: 1444333259 | ISBN-13: 978-1-444333251 2. L. E. Bryan (Ed.), Antimicrobial Drug Resistance, Academic Press, 1984, ISBN-10: 012138120X | ISBN-13: 978-0121381202 3. Bernard D.Davis et al., Microbiology, Harper International Edition, ISBN-10: 0061406910 ISBN-13: 9780061406911 Reference Books: 4. Gerhadt P et al., Manual of Methods for General Bacteriology, American Society for Microbiology, 1981, ISBN-10: 0914826301 | ISBN-13: 978-0914826309. 5. Pelczer Jr. Chan. Creig, Microbiology: Concepts and Applications, McGraw Hill Inc, 1993, ISBN-10: 0070492581 | ISBN-13: 9780070492585 6. L. M. Prescott, J. P. Harley, D. A. Klein, Microbiology, 6th ed., McGraw-Hill, 2004, ISBN-10: 0697293904 | ISBN-13: 9780697293909

Course Code	**BSE 629**
Title of the Course	**Genetics**
Credit Structure	L-T-P-Credits 2-0-0-2
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to take students through basics of genetics and classical genetics covering prokaryotic/phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.
Course Outcome	On successful completion of this course, student will be able : ● Describe fundamental molecular principles of genetics; ● Understand relationship between phenotype and genotype in human genetic traits; ● Describe the basics of genetic mapping; ● Understand how gene expression is regulated.
Course Syllabus	**Genetics of bacteria and bacteriophages:** Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene. **Yeast genetics:** Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis. **Drosophila genetics as a model of higher eukaryotes:** Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism. **Population genetics and genetics of Evolution:** Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & genetic fitness. **Quantitative genetics of complex traits (QTLs):** Complex traits, mapping QTLs, yeast genomics to understand biology of QTLs. **Plant genetics:** Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.

Suggested Books	Text Books: 1. Hartl, D. L., & Jones, E. W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett. (1998). (ISBN-10 : 076370489X; ISBN-13 : 978-0763704896) 2. Pierce, B. A. Genetics: a Conceptual Approach. New York: W.H. Freeman. (2005). (ISBN-10 : 146410946X; ISBN-13 : 978-1464109461) Reference Books: 3. Tamarin, R. H., & Leavitt, R. W. Principles of Genetics. Dubuque, IA: Wm. C. Brown. (1991). (ISBN-10 : 0697354628; ISBN-13 : 978- 0697354624) 4. Smith, J. M. Evolutionary Genetics. Oxford: Oxford University Press. (1998). (ISBN: 9780198502319)

Course Code	**BSE 625**
Title of the Course	**Emerging Technologies**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions.
Course Outcome	The course will enable students to understand the basis of technologies in biological and life science research. Students will be able to analyze and interpret the data obtained and critical factors associated in the measurements using different emerging techniques. Students will also be able to apply the techniques in solving typical research problems.
Course Syllabus	**Light Microscopy:** Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy; optical arrangement, CCD cameras. **Confocal microscopy:** scanning optical microscope, confocal principle, light source, pinhole and signal channel configurations, detectors; signal-to-noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; Advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near- Field Microscopy; Introduction to beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM). **Electron Microscopy:** Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy, cryo- electron microscopy, **Spectroscopy Techniques:** UV-Visible spectroscopy, CD spectroscopy, Fluorescence spectroscopy, Nuclear magnetic resonance & solid-state NMR **Mass spectroscopy** Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.

	Structural biology X-ray diffraction methods, small-angle X-ray scattering, **CRISPR-CAS** History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation therapeutic method. **Nanobodies:** Introduction, combining nanobody with phage- display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.
Suggested Books	Text Books: 1. Campbell, I. D. Biophysical Techniques. Oxford: Oxford University Press. (2012). (ISBN-13: 9780199642144) 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. (2007). (ISBN-10: 052181524X; ISBN-13: 978- 0521815246) Reference Books: 3. Phillips, R., Kondev, J., & Theriot, J. Physical Biology of the Cell. New York: Garland Science. (2009). (ISBN-10: 9780815344506; ISBN-13: 978- 0815344506) 4. Nelson, P. C., Radosavljević, M., & Bromberg, S. Biological Physics: Energy, Information, Life. New York: W.H. Freeman. (2004). (ISBN-10: 0716798972; ISBN-13: 978-0716798972) Selected papers from scientific journals.

Course Code	**BSE 614**
Title of the course	**General Physiology**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The course will cover the fundamentals of Physiology
Course Outcome	Students will be able to understand the various physiological activities inside organelles. How dysregulation of normal physiology leads to biochemical changes which ultimately bring symptoms in form of diseases. How to rationalize a usual person physiological needs and associated consequences.
Course Syllabus	**Introduction to Physiology:** The scope of human physiology, Elementary tissues- epithelial tissue, connective tissue, muscle tissue, nervous tissue, homeostasis, blood buffers, acid base balance, hormones **Muscle physiology:** Muscles classification, skeletal muscle, smooth muscle, muscle contraction, membrane excitation, neuromuscular junction, and rigor mortis **Renal physiology**: Kidney, nephron, renal circulation, GFR, renal regulation of water and electrolyte balance **Cardiovascular Physiology:** Heart, cardiac muscle, action potential in cardiac muscle, cardiac cycle, heart sounds, conducting mechanism, heart beat and regulation, cardiac output, ECG, blood pressure, role of baro and chemo receptors in blood pressure regulation, composition and functions of blood, plasma proteins and functions, cellular content of blood- haematopoiesis, haemoglobin, haemostasis, blood groups, blood transfusion, lymph **Respiratory physiology:** Organization of respiratory system, respiratory membrane, pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation, surfactants, exchange of gases, transport of gases, regulation of respiration, hypoxia, cyanosis, hypercapnia, dyspnea, apnea, periodic breathing, artificial respiration **Digestive physiology:** Salivary gland and secretion, gastric gland and secretion, secretion of pepsinogen, HCl secretion and regulation, pancreas, liver, bile

Suggested Books	Text Books: 1. E. P. Widmaier, H. Raff, K. T. Strang, Vander's Human Physiology- The Mechanism of Body Function. 12th ed., McGraw Hill, 2010, ISBN-10: 0077350014. 2. J. E. Hall, M. Vaz, A, Kurpad, T. Raj, Text Book of Medical Physiology, 2nd ed., Elsevier Health-INR, 2016, ISBN-10: 8131244660. Reference Books: 3. J. B. West, Physiological Basis of Medical Practice, 12th ed., Lippincott Williams & Wilkins, 1990, ISBN-10: 0683089471. 4. W. F. Ganong, Review of Medical Physiology, 25th ed., McGraw Hill Education, 2016, ISBN-10: 007182510X. 5. K. Sembulingam, P. Sembulingam, Essentials of Medical Physiology, 7th ed., Jaypee Brothers Medical Publishers, 2016, ISBN-10: 9385999117.

Course Code	**BSE 651N**
Title of the Course	**Biochemistry Lab**
Credit Structure	L-T- P-Credits 0-0-4-2
Name of the Concerned Department	Biosciences and Biomedical Engineering
Pre–requisite, if any	Basic biochemistry courses at the undergraduate level
Course Objective	This course aims to introduce basic laboratory techniques in biochemistry through experiments that will be conducted as Experimental Projects.
Course Outcome	Students will be acquainted with the principles and procedures of various experiments in Biochemistry and get hands-on training/experience in handling enzymes along with learning biochemical analysis techniques.
Course Syllabus	List of representative experiments: ● To prepare an Acetic-NaAcetate buffer system and validate the Henderson-Hasselbach equation. ● To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer-Lambert's Law. ● Titration of Amino Acids and separation of aliphatic, aromatic, and polar AA by TLC. ● An enzyme purification theme (such as *E. coli* alkaline phosphatase): (a) Preparation of cell-free lysates, (b) ammonium sulfate precipitation, (c) Ion-exchange chromatography, (d) Gel filtration, (e) Affinity chromatography, (f) Generating a purification table, (g) Assessing purity by SDS0PAGE gel electrophoresis, (h) Assessing purity by 2D-gel electrophoresis, and (i) Enzyme kinetic parameters: Km, Vmax, and Kcat.
Suggested Books	Reference Books: 1. D. Holme, H. Peck, Analytical Biochemistry, 3rd ed., Longman, 1998, ISBN-10: 058229438X. 2. R. K. Scopes, Protein Purification -Principles & Practices, 3rd ed., Springer International Edition, 2014, ISBN-10: 8132214838. 3. D. Freifelde, Physical Biochemistry: Application to Biochemistry and Molecular Biology, 2nd ed., W. H. Freeman, 1983, ISBN-10: 0716714442.

	4. K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry, 5th ed., Cambridge University Press, 2000, ISBN-10: 052165873X.

Course Code	**BSE 659N**
Title of the Course	**Microbiology Lab**
Credit Structure	L-T- P-Credits 0-0-4-2
Name of the Discipline	Biosciences and Biomedical Engineering
Pre–requisite, if any	Basic biology courses undergraduate level
Course Objective	This course aims to introduce basic laboratory techniques in microbiology (Bacteriology, Virology, Immunology) through experiments that will be conducted as Experimental Projects.
Course Outcome	Upon successful completion of this course, the students will be able to : ● Demonstrate safe laboratory practices while handling microorganisms, chemicals, and equipment. ● Understand and apply aseptic techniques to prevent contamination and ensure safety in microbial culturing. ● Use a light microscope to observe microbial structures, including bacteria, fungi, and protozoa. ● Analyze Microbial Growth and Metabolism: ● Critical Thinking and Troubleshooting in the Laboratory
Course Syllabus	List of representative experiments: ● Introduction to Light Microscopy, Laboratory Procedure for Microscopic Examination ● Introduction to laboratory sterilization technique, Media Preparation; Bacterial Culture Media preparation and sterilization ● Bacterial Isolation, Culturing Techniques and Microscopic Examination of Bacterial Morphology, Structures, Motility. ● Antigen-Antibody Reactions; Agglutination and Precipitation Techniques ● Introduction to virological methods and techniques. Animal cell culture techniques, cell propagation, cell counting, maintenance ● Quantification of the virus by plaque assay. Reverse transcription PCR techniques ● Enzyme-Linked Immunosorbent Assay (ELISA) assay for viral antigen detection, Western Blot ● Cell staining and immunofluorescence techniques, Image acquisition through epifluorescence techniques
Suggested Books	Reference Books: 1. M. R. Green, J. Sambrook, Molecular Cloning: A Laboratory Manual, 4th ed., Cold Spring Harbor Laboratory Press, 2012, ISBN-10: 9781936113422. 2. A. Oller, Microbiology Lab Manual, Spi Lab Edition, Kendall Hunt Pub Co., 2016, ISBN-10: 1465295380. 3. J. G. Cappuccino, C. T. Welsh, Microbiology: A Laboratory Manual, 11th ed., Pearson, 2016, ISBN-10: 0134098633.

Course Code	HS 641

Course Title	**English Communication Skills**
Contact Hours	L-T-P 2-0-2- **[Grades: Pass (PP) or No Pass (NP)]**
Name of the Concerned Discipline/School	Humanities and Social Sciences (HSS)
Pre–requisite, if any	NIL
Course Syllabus	**Communication Fundamentals:** Stages of Communication, Channels of Communication, Technical Communication Skills, Barriers to Effective Communication **Listening Comprehension:** Types of Listening, Listening with a Purpose, Barriers to Listening, Improving Listening comprehension, Listening and Note Taking **Speaking:** The Speech Process, Conversation (Telephonic) and Oral Skills, Body Language, Phonetics and Spoken English, Speaking Techniques in a Global Village **Group Discussion:** Importance of Group Discussion Skills, Characteristics of Successful Group Discussion, Group Discussion Strategies, Techniques for Individual Contribution, Group Interaction Strategies, Group Discussion in Action (video recording) **Presentation Skills:** Planning the Presentation, Preparing the Presentation, Improving Delivery, Checklist for Effective Presentation (oral) **Study Skills:** Reading Comprehension, Note Making Summarising and Paraphrasing, Referencing **Grammar Review:** Parts of Speech, Use of Articles, Prepositions, Modals, Tenses, Active and Passive, For M.S., Direct and Indirect Speeches, Conditional Sentences, Question Tags, Common Errors **Writing Strategies:** Writing Effective Sentences, Sentence Coherence, Paragraph and Essay Writing Report Writing, Proposals and Articles **The Craft of Business Letter Writing:** Essentials of Effective Correspondence, The Lay-out of a Business Letter, Formats for Typing: Block and Indented Styles, Salutation, Subject, Body and Closures, Resumes and Cover Letters **Development of Vocabulary and Soft Skills**
Suggested books	Reference Books: 1. M. Raman and S. Sharma, **Technical Communication: English Skills for Engineers**, Oxford University Press, 2011 2. K. Mohan and M. Banerji, **Developing Communication Skills**, McMillan Co., 1990. 3. **Oxford Advanced Learner's Dictionary**, Oxford University Press, 2010(8th edition) (with CD). 4. M. Swan, **Practical English Usage**, Oxford University Press, 1996. 5. Reid & Martin

1st Year: Semester-II

Course Code	**BSE 6XX (BSE 624)**
Title of the Course	**Bioprocess Engineering and Technology**
Credit Structure	L-T-P-Credits 2-1-0-3

Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of the biotechnology industry.
Course Outcome	Understand what bioprocess engineering and what bioprocess engineers do. • Describe bioprocesses with a focus on large scale processing and downstream processing • Perform process calculations for common bioprocesses • Understand the issues in scaling up bioprocesses, process economics and regulatory issues.
Course Syllabus	**Basic principles of biochemical engineering:** Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics. **Stoichiometry and models of microbial growth:** Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth. **Bioreactor design and analysis:** Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters. **Downstream processing and product recovery:** Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging. **Fermentation economics:** Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath- process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal. **Applications of enzyme technology in food processing:** Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions. e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein, etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. **Applications of microbial technology in food process operations and production, biofuels and biorefinery:** Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery.
Suggested Books	Text Books: 1. Shuler, M. L., & Kargi, F. Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall. 2002. (ISBN: 0131228579) 2. Stanbury, P. F., & Whitaker, A. Principles of Fermentation Technology. Oxford: Pergamon Press. 2016. (ISBN: 0080999530) 3. Bailey, J. E., & Ollis, D. F. Biochemical Engineering Fundamentals. New York: McGraw-Hill. 1986. (ISBN: 9780070701236)

	Reference Books: 4. Blanch, H. W., & Clark, D. S. Biochemical Engineering. New York: M. Dekker. 1997. (ISBN 9780824700997) 5. El-Mansi, M., & Bryce, C. F. Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis. 2007. (ISBN: 9780429190605)

Course Code	**BSE 6XX**
Title of the Course	**Plant and Animal Biotechnology**
Credit Structure	2-1-0-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	Nil
Course Objective	The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.
Course Outcome	Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.
Course Syllabus	**Plant Tissue Culture And Animal Cell Culture:** Plant tissue culture: totipotency; organogenesis; Somatic embryogenesis; establishment of cultures, media preparation; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; somatic hybridization; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. **Animal Cell Culture:** brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. **Plant Genetic Manipulation:** Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T- DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer methods; markers for screening and selection; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as bio factories. **Animal Reproductive Biotechnology And Vaccinology:** Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning; Vaccinology: history of development of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines. **Plant and animal Genomics:** Overview of genomics – definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels – DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research – databases; overview of forward and reverse genetics for assigning function for genes.

	<u>Molecular Mapping And Marker Assisted Selection</u>: Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting; introduction to mapping of genes/QTLs; strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.
Suggested Books	Text Books: 1. Chawla, H. S. Introduction to Plant Biotechnology. Third Edition, Publisher: Oxford & IBH Publishing Co Pvt. Ltd. (2000). (ISBN: 9788120417328) 2. Razdan, M. K. Introduction to Plant Tissue Culture. Third edition, Oxford & IBH Publishing Co Pvt. Ltd. (2019). (ISBN: 978-8120417939) 3. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press. (2008). (ISBN: 9780199282616) 4. Glick, B. R., & Pasternak, J. J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press. (2010). (ISBN: 978-1555814984) 5. Pörtner, R. Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press. (2007). (ISBN: 978-1- 59745-399-8) Reference Books: 6. Buchanan, B. B., Gruissem, W., & Jones, R. L. Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons. (2015). (ISBN: 978-0-470-71421-8) 7. Brown, T. A. Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Pub. (2006). (ISBN: 978- 1119072560) 8. Primrose, S. B., & Twyman, R. M. Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub. (2006). (ISBN: 1-4051-3544-1) 9. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press. (2008). (ISBN: 9780199282616) 10. Levine, M. M. New Generation Vaccines. New York: M. Dekker. (2004). (ISBN: 0824740718)

Course Code	**BSE 618**
Title of the Course	**Bioinformatics**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
Course Outcome	Student should be able to: ● Develop an understanding of basic theory of these computational tools; ● Gain working knowledge of these computational tools and methods; ● Appreciate their relevance for investigating specific contemporary biological questions; ● Critically analyse and interpret results of their study
Course Syllabus	**Bioinformatics basics**: Computers in biology and medicine; biological database and

	search tools; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools. **DNA sequence analysis**: DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; **Multiple sequence analysis**: multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: **Protein Modelling**: introduction; force field methods; energy, buried and exposed residues; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing. **Protein structure prediction**: protein folding and model generation; secondary structure prediction and analysis; protein loop searching; loop generating methods; homology modelling; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design. **Practical:** (1) Using NCBI and Uniprot web resources. (2) Introduction and use of various genome databases. (3) Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/TrEMBL, UniProt. (4) Similarity searches using tools like BLAST and interpretation of results. (5) Multiple sequence alignment using ClustalW. (6) Phylogenetic analysis of protein and nucleotide sequences. (7) Use of gene prediction methods (GRAIL, Genscan, Glimmer). (8) Using RNA structure prediction tools. (9) Use of various primer designing and restriction site prediction tools. (10) Use of different protein structure prediction databases (PDB, SCOP, CATH). (11) Construction and study of protein structures using Deepview/PyMol. (12) Homology modelling of proteins. (13) Use of tools for mutation and analysis of the energy minimization of protein structures. (14) Use of miRNA prediction, designing and target prediction tools.
Suggested Books	Text Books: 1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press. (ISBN-10 : 0199251967, ISBN-13 : 978-0199251964) 2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis.Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. (ISBN-10 : 0879696087, ISBN-13 : 978-0879696085) Reference Books: 3. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ: Wiley-Blackwell. (ISBN-10 : 1118581784, ISBN-13 : 978-1118581780)

Course Code	**BSE 702**
Title of the Course	**Applied Genetic Engineering**
Credit Structure	L-T-P-C 2-1-0-3
Name of the Concerned Discipline	Biosciences and Biomedical Engineering
Pre–requisite, if any	Basic knowledge of molecular biology
Course Objective	The course is intended to give students an overview of various genetic engineering techniques and its applications.
Course Outcome	Upon completing course, students should be able to understand fundamental concepts, techniques, and applications of genetic manipulation, including recombinant DNA technology, gene cloning, and the ethical considerations surrounding these technologies.
Course Syllabus	Concept of recombinant DNA technology and purpose, basic methodology, use of plasmids, restriction endonucleases, linkers, adaptors, ligation; Transformation, methods in screening recombinant DNA; methods for labelling DNA, modifying enzymes, hybridization techniques: northern, Southern and colony hybridization; Restriction maps and mapping techniques; PCR technology, primer design; Construction of cDNA libraries in plasmids, Gene amplification, RT-PCR and quantitative RT-PCR; Strategies for maximizing gene expression, prokaryote expression vectors and their applications in expression, quantitation, purification; Inclusion bodies, approaches to solubilisation; Cloning in M13 mp vectors, application to DNA sequencing, site-directed mutagenesis; PCR-based mutations; Vectors: cosmid vectors, yeast artificial chromosome; selection and screening recombinant phage, in vitro packaging, genomic libraries and cDNA cloning; principles and application of di-hybrid systems; Cloning and expression in mammalian cells, methods of selection and screening, application of reporter genes; Applications in mammalian genetic engineering, Biopharmaceuticals, Transgenics in animals and plants, restriction fragment length polymorphism, DNA fingerprinting, human genetic diseases; Gene targeting, human gene therapy, Automated DNA sequencing, Man-made antibodies, phage display; Basic principles of transcriptomics and proteomics.
Suggested Books	**Text Books** 1. Old W. & Primrose; Principles of Gene Manipulation. 6th ed., S. B. University Press, 2001. [ISBN-10: 0632059540 ISBN-13: 978-0632059546] 2. Maniatis T., Fritsch E. F. & Sambrook J.; Molecular Cloning: A Laboratory Manual. CSHL, 3rd ed., 2002. [ISBN-10: 0879695773 | ISBN-13: 978-0879695774] 3. Innis M.A., Gelfand D.H., Sninsky J.J. & White T.J. PCR Protocols. Academic Press, 1990. [ISBN 0-12-372181-4] Reference Books: 1. Hardin C, Edwards J, Riell A, Presutti D, Miller W and Robertson D; Cloning, Gene Expression and Protein Purification: Experimental procedures and process rationale. Oxford University Press, 2001. [ISBN-10: 0195132947 ISBN-13: 978-0195132946] 2. Davies K.E. et al., Genome Analysis - A Practical Approach, 1988. [ISBN-10: 1852211105 ISBN-13: 978-1852211103]

BSE 6XX	BSBE Flexicore II	2-1-0	3

Course Code	**BSE 608**
Title of the course	**Advanced Drug Delivery Systems**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Department	Biosciences and Biomedical Engineering
Pre–requisite, if any	Basic Biology
Course Objective	The course will cover newer advances in drug delivery systems and recent trends for development characterization and applications of delivery systems to solve healthcare problems.
Course Outcome	Students will get to understand different critical factors governing the development of drug delivery systems, and various types of novel drug delivery systems in research and in industry, their production techniques and critical quality control parameters.
Course Syllabus	Introduction to drug delivery systems, Controlled release systems, Influence of drug properties and routes of drug administration on the delivery Oral controlled drug delivery systems and their mechanisms, Examples and Case Studies Controlled drug delivery systems: Micro-particles, liposomes, niosomes, polymeric nanoparticles, solid lipid nanoparticles, carbon nanotubes, implants etc., Examples and Case Studies Transdermal drug delivery systems: Principles of skin permeation, Factors affecting percutaneous absorption of drugs, Development and evaluation of transdermal devices, Examples and Case Studies Targeted drug delivery systems: active and passive targeting, Enhanced permeation and Retention (EPR) effect, receptor mediated endocytosis, prodrug based drug targeting, brain targeting, tumour targeting. Examples and Case Studies
Suggested Books	Text Books: 1. P.V. Devarajan, S. Jain, Targeted Drug Delivery: Concepts and Design, Springer International Publishing Switzerland, 2015, [ISBN: 978-3-319-11355-5] 2. J. R. Robinson, V. H. L. Lee, Controlled Drug Delivery: Fundamentals and Applications. Taylor and Francis UK, 1987, [ISBN: 978-0824775889] 3. J. Siepmann, R. A. Siegel, M. J. Rathbone, Fundamentals and Applications of Controlled Release Drug Delivery, Springer Switzerland, 2012, [ISBN 978-1-4614-0880-2] Reference Books: 4. A. S. Narang, R. I. Mahato Targeted Delivery of Small and Macromolecular Drugs, CRC Press USA, 2010, [ISBN: 9781420087727] 5. C. A. Lorenzo, A. Concheiro, Smart Materials for Drug Delivery, RSC Publishing UK, 2013, [ISBN: 978-1-84973-552-0] 6. Selected articles from journals like Journal of Controlled Release, International Journal of Pharmaceutics, Journal of Pharmaceutical Sciences etc.

Course Code	**BSE 628**
Title of the Course	**Genomics and Proteomics**
Credit Structure	L-T-P-Credits (2-1-0-3)
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objective of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.
Course Outcome	How Omics integration helpful in modern healthcare in forms of biomarker discovery and therapeutic determination. Helpful to dissect personalized medicine and understanding the modern highthroughput technology to solve this domain.
Course Syllabus	**Basics of genomics and proteomics:** Brief overview of prokaryotic and eukaryotic genome organization. **Genome mapping:** Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, in situ hybridization, comparative gene mapping. **Genome sequencing projects:** Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. **Comparative genomics:** Identification and classification of organisms using molecular markers, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence. **Proteomics:** Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2- hybrid system, proteome databases. **Functional genomics and proteomics:** Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; **Introduction to metabolomics, lipidomics, metagenomics and systems biology.**
Suggested Books	Text Books: 1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub. (ISBN-10 : 1405135441, ISBN-13 : 978-1405135443) 2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press. (ISBN-10 : 0896039919, ISBN-13 : 978-0896039919) Reference Book: 3.Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings. (ISBN-10 : 9780805382198, ISBN-13 : 978-0805382198)

Course Code	**BSE 6XX**
Title of the Course	**Scientific Communication Skills**
Credit Structure	L-T-P-Credits **0-2-0-2**

Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to give a background on the history of science, emphasizing methodologies used to do research, use the framework of these methodologies for understanding effective lab practices and scientific communication and to appreciate scientific ethics. To familiarize students with classic literature to make them appreciate how ground- breaking discoveries were made.
Course Outcome	• Understand the research process. • Develop ability to build literature database and use at least one reference management system to store that information. • Develop and practice effective oral and written communication strategies.
Course Syllabus	Scientific method, reasoning; reductionist vs holistic biology. Preparation for research: Choosing a mentor, laboratory, research question, and maintaining a lab notebook. Understanding communication and practicing effective communication strategies. Practicing Technical writing skills, technical reports, abstracts, peer-reviewed journal papers, thesis and dissertation, other forms of communicating with general public Ethics in research, Avoiding and preventing scientific misconduct, plagiarism, recognizing contributions and determining authorship, rights and responsibilities of authorship, peer review process and problems, recent developments such as open access and non-blind review; plagiarism. Foundations for a productive career, understanding career options, career planning.
Suggested books	Refernece Books: 1. Valiela, I. Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press. 2001. (ISBN:0195134133) 2. On Being a Scientist: a Guide to Responsible Conduct in Research. Washington, D.C.: National Academies Press. 2009. (ISBN: 9780309141352) 3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558. Selected papers for critical analysis as described below **1. Classic Papers on Molecular Biology (partial list)** 1. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8 2. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA. Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82 Note: 3. In vivo alteration of telomere sequences and senescence caused by mutated Tetrahymena telomerase RNAs Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990 **2. Classic Papers on Cell Biology (partial list)** 1. A protein-conducting channel in the endoplasmic reticulum, Simon SM AND

Course Code	**BSE 652**
Title of the Course	**Genetic Engineering Lab**
Credit Structure	L-T-P-Credits 0-0-4-2

Name of the Concerned Department	Biosciences and Biomedical Engineering
Pre–requisite, if any (for the students)	None
Course Objective	The emphasis of the lab is on understanding the principles behind experiments, the ability to design and execute experiments and time management. The purpose of various steps and project planning will be discussed.
Course Outcome	Students should be able to gain hands-on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.
Course Syllabus	List of representative experiments: 1. Isolate genomic DNA from *Bacillus subtilis* (or equivalent organism) genome 2. PCR amplification of *flgM* gene and analysis by agarose gel electrophoresis 3. Preparation of plasmid pET-28a from *E. coli* DH5a and gel analysis 4. Restriction digestion of vector (gel analysis) and insert with *Nco*I and *Xho*I 5. Vector and insert ligation, b. Transformation in *E. coli* DH5a. 6. Plasmid isolation and confirming recombinant by PCR and RE digestion. 7. Transformation of recombinant plasmid in BL21(DE3). 8. Induction of FlgM protein with IPTG and analysis on SDS-PAGE. 9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE. 10. Random primer labeling of *flgM* with Dig-11-dUTP 11. Southern hybridization of *B. subtilis* genome with probe and non-radioactive detection.
Suggested Books	Refernece Books: 1. T. Maniatis, E.F. Fritsch, J. Sambrook, Molecular Cloning: A Laboratory Manual. 3rd ed., Cold Spring Harbor Laboratory Press, 2002, ISBN-10: 0879695773. 2. C. Hardin, J. Edwards, A. Riell, D. Presutti, W. Miller, D. Robertson, Cloning, Gene Expression and Protein Purification: Experimental Procedures and Process Rationale, 1st ed., Oxford University Press, 2001, ISBN-10: 0195132947. 3. M. A. Innis, D.H. Gelfand, J. J. Sninsky, PCR Applications: Protocols for Functional Genomics, 1st ed., Academic Press, 1999, ISBN-10: 0123721865. 4. D. J. Park, PCR Protocols, 3rd ed., Humana Press, 2011, ISBN-10: 1607619431. 5. S. B. Primrose, R. M. Twyman, Principles of Gene Manipulation and Genomics, 7th ed., Wiley India, 2014, ISBN-10: 8126548398.

Course Code	**BSE 6XX**
Title of the Course	**Bioprocess Engineering and Technology Laboratory**
Credit Structure	L-T-P-Credits 0-0-4-2

Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this laboratory course are to provide hands-on training to students in upstream and downstream unit operations.
Course Outcome	Students should be able to: ● Investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems; ● Apply skills and knowledge gained will be useful in solving problems typical of bio industries and research.
Course Syllabus	List of representative experiments: ● Basic Microbiology techniques; Scale up from frozen vial to agar plate to shake flask culture; Instrumentation: Microplate reader, spectrophotometer, microscopy. ● Isolation of microorganisms from soil samples; Experimental set-up; Assembly of bioreactor and sterilization; Growth kinetics; Substrate and product inhibitions; Measurement of residual substrates; Data Analysis; Introduction to Metabolic Flux Analysis (MFA); ● Fermentation Batch Fed-batch; Continuous Unit operations; Microfiltrations: Separation of cells from broth; ● Bioseparations: Various chromatographic techniques and extractions; Bioanalytics: ● Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates.
Suggested Books	Refernece Books: 1. Shuler, M. L., & Kargi, F. Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall. 2002. (ISBN: 0131228579) 2. Stanbury, P. F., & Whitaker, A. Principles of Fermentation Technology. Oxford: Pergamon Press. 2016. (ISBN: 0080999530) 3. Blanch, H. W., & Clark, D. S. Biochemical Engineering. New York 4. M. Dekker. 1997. (ISBN 9780824700997) 5. Bailey, J. E., & Ollis, D. F. Biochemical Engineering Fundamentals. New York: McGraw-Hill. 1986. (ISBN: 9780070701236) 6. El-Mansi, M., & Bryce, C. F. Fermentation Microbiology and Biotechnology.

Course Code	**BSE 6XX**
Title of the Course	**Plant and Animal Biotechnology Laboratory**
Credit Structure	L-T-P- Credits 0-0-4-2
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to provide hands-on training in basic experiments of plant and animal biotechnology.
Course Outcome	On completion of course, students should be able to gain basic skills in plant and animal biotechnology.
Course Syllabus	List of representative experiments: **Plant Cell Culture:**

	1. Prepare culture media for plant tissue culture and prepare explants of *Valleriana wallichii* for inoculation. Attempt in vitro andro and gynogenesis in plants (*Datura stramonium*). 2. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG. 3. Culture Agrobacterium tumefaciens and attempt transformation of any dicot species. 4. Generate an RAPD and ISSR profile of *Eremurus persicus* and *Valleriana wallichii*. 5. Prepare karyotypes and study the morphology of somatic chromosomes of Allium cepa, A. sativum, A. tuberosum and compare them on the basis of karyotypes. 6. Undertake plant genomic DNA isolation by CTAB method and its quantitation 7. Perform PCR amplification and study genetic fingerprinting profiles of plants and calculate polymorphic information content. **Animal Cell Culture:** 1. Count cells of an animal tissue and check their viability. Prepare culture media with various supplements for plant and animal tissue culture. 2. Prepare single cell suspension from spleen and thymus. Monitor and measure doubling time of animal cells. 3. Chromosome preparations from cultured animal cells. Isolate DNA from animal tissue by SDS method. Attempt animal cell fusion using PEG.
Suggested Books	Refernece Books: 1. Chawla, H. S. Introduction to Plant Biotechnology. Third Edition, Publisher: Oxford & IBH Publishing Co Pvt. Ltd. (2000). (ISBN: 9788120417328) 2. Razdan, M. K. Introduction to Plant Tissue Culture. Third edition, Oxford & IBH Publishing Co Pvt. Ltd. (2019). (ISBN: 978-8120417939) 3. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press. (2008). (ISBN: 9780199282616) 4. Buchanan, B. B., Gruissem, W., & Jones, R. L. Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons. (2015). (ISBN: 978-0-470-71421-8) 5. Glick, B. R., & Pasternak, J. J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press. (2010). (ISBN: 978- 1555814984) 6. Brown, T. A. Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Pub. (2006). (ISBN: 978- 1119072560) 7. Primrose, S. B., & Twyman, R. M. Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub. (2006). (ISBN: 1-4051-3544-1) 8. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press. (2008). (ISBN: 9780199282616) 9. Levine, M. M. New Generation Vaccines. New York: M. Dekker. (2004). (ISBN: 0824740718) 10. Pörtner, R. Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press. (2007). (ISBN: 978-1- 59745-399-8)

Course Code	**BSE 6XX**

Title of the Course	**Research Ethics and Research Methodology**
Credit Structure	**P/NP**
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to give background on the history of science, emphasizing methodologies used to do research, use the framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.
Course Outcome	Students should be able to: • Understand the history and methodologies of scientific research, applying these to recent published papers; • Understand and practice scientific reading, writing and presentations; • Appreciate scientific ethics through case studies.
Course Syllabus	**History of science and science methodologies** Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology. **Preparation for research** Choosing a mentor, lab and research question; maintaining a lab notebook. **Ethical issues** Scientific misconduct; publishing scientific papers - peer review process and problems, plagiarism; software for plagiarism.
Suggested Books	Reference Books: 1. Elizabeth A. Buchanan (2003). Readings in Virtual Research Ethics: Issues and Controversies. Information Science Publishing. ISBN 13: 9781591401520

2nd Year: Semester–III

Course Code	**BSE 6XX**
Title of the Course	**Immunology and Immunotechnology**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Biosciences and Biomedical Engineering
Pre–requisite, if any	Open to all graduates, with the prior permission of course instructor.
Course Objective	This course deals with immune systems and their components at the cellular and humoral levels. Furthermore, this course deals with the practical aspects such as the production and engineering of antibodies, the application of antigens, the design of (recombinant) vaccines, strategies for immune intervention, etc.
Course Outcome	On completion of this course, students should be able to: ● Evaluate the usefulness of immunology in different pharmaceutical companies; ● Identify proper research labs working in the area of their own interests; ● Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial).
Course Syllabus	**Introduction to immunology**. Cells & organs of immune system-lymphoid cells, B and T lymphocytes, null cells. Mononuclear cells- phagocytosis, antimicrobial and cytotoxic activities. Granulocytes- neutrophils, eosinophils and basophils. Mast cells, dendritic cells. Organs of the immune system- primary and secondary lymphoid organs. **Immunoglobulins:** Structure and function-basic and fine structures of immunoglobulins. Isotypes, allotypes and idiotypes Classification of immunoglobulins. Genetic control of antibody response. Generation of antibody diversity. Theories of antibody formation. Clonal selection theory. Antigen-antibody interaction- strength of antigen-antibody interaction, cross reactivity, precipitin reactions. Radioimmunoassays (RIA). Enzyme linked immunosorbent assay (ELISA). Western blotting. immunoelectron microscopy. Complement proteins, complement features, classical and alternative pathways. **Major histocompatibilty complex** (**MHC**): Structure and its significance. Transplantation immunity- immunological basis of graft rejection, xenotransplantation. Clinical manifestation of graft rejection. General and specific immuno suppressive therapy. Clinical transplantation. Hypersensitivity- type I, II, III, and IV hypersensitivity. **Autoimmunity**: Basis of autoimmune disorders, mechanism for the induction of autoimmunity. Treatment of autoimmune diseases. Immune response to infectious diseases. Antigen presentation via Class I and Class II pathways. Th1/ Th2 polarities, NK Effector Mechanism. Apoptosis. Monoclonal antibodies- production role and advantages of monoclonal antibodies. Detailed account on the application and uses of monoclonal antibodies. Humanization of antibodies. **Cancer Immunology:** Role of cytotoxic T lymphocytes in cancer immunology. AIDS pathogenesis, immunology of retroviruses, role of chemokines in management of AIDS. Vaccine technology, active and passive immunity, development of vaccine against infectious diseases.
Suggested Books	Text Books: 1. T. J. Kindt, R. A. Goldsby, B. A. Osborne. Immunology, 6th ed., W. H. Freeman, 2006, ISBN-10: 0716767643. 2. A. K. Abbas, A. H. Lichtman, Cellular and Molecular Immunology, 8th ed., Saunders, 2014, ISBN-10: 0323222757.

	Reference Books: 3. D. K. Male, J. Brostoff, D. E. Roth, I. M. Roitt, Immunology, 8th ed., Elsevier, 2012, ISBN-10: 0323080588. 4. T. Doan, R. Melvold, S. Viselli, C. Waltenbaugh, Immunology, 2nd ed., Lippincott Williams & Wilkins, 2012, ISBN-10: 8184737637.

Course Code	**BSE 622**
Title of the Course	**Molecular Diagnostics**
Credit Structure	L-T-P-Credits 2-0-0-2
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	Sensitizing students with various facets of molecular medicines which can alter several diseases
Course Outcome	Apply molecular biology techniques for genetic analysis and disease diagnosis. Evaluate the impact of molecular diagnostics in clinical applications, including personalized medicine, inherited disease detection and microbial pathogen identification.
Course Syllabus	**Genome biology in health and disease:** DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs. **Genome**: resolution, detection & analysis PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis. **Diagnostic metabolomics** Metabolite pro le for-biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms. **Detection and identity of microbial diseases** Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics. **Detection of inherited diseases** Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes. **Molecular oncology** Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco- therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies. **Quality assurance and control** Quality oversight; regulations and approved testing.
Suggested Books	Text Books: 1. Campbell, A. M., & Heyer, L. J., Discovering Genomics, Proteomics, and Bioinformatics. Benjamin Cummings, San Francisco, 2006, (ISBN 978-81- 317-1559-8).

	2. Brooker, R. J.. Genetics: Analysis & Principles. New York, NY: McGraw- Hill, 2009, (ISBN: 9781259616020). Reference Books: 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press. 2017, (ISBN: 978-1-555-81936-1). 4. Coleman, W. B., & Tsongalis, G. J. Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press. 2010, (ISBN 978-1- 59259-928-8).

BSE XXX	**Elective – I (Department)**	2-1-0	3
BSE XXX	**Elective – II (Department)**	2-1-0	3
ZZ XXX	**Elective – III (Institute)**	2-1-0	3

Course Code	**BSE 6XX**
Title of the Course	**Immunology Laboratory**
Credit Structure	L-T-P-Credits **0-0-4-2**
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	**None**
Course Objective	The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells etc. and how they can be used in respective research work.
Course Outcome	Students should be able to: ● Evaluate the usefulness of immunology in different pharmaceutical companies; ● Identify proper research lab working in area of their own interests; ● Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.
Course Syllabus	List of representative experiments: ● Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage. ● Antibody titre by ELISA method. ● Double diffusion, Immuno-electrophoresis and Radial Immunodiffusion. ● Complement fixation test. ● Isolation and purification of IgG from serum or IgY from chicken egg. ● SDS-PAGE, Immunoblotting, Dot blot assays. ● Blood smear identification of leucocytes by Giemsa stain. ● Separation of leucocytes by dextran method. ● Demonstration of Phagocytosis of latex beads and their cryopreservation. ● Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation. ● Demonstration of ELISPOT. ● Demonstration of FACS.
Suggested Books	Reference Books: 1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Immunology. New York: W.H. Freeman. (ISBN-10 : 1429202114, ISBN-13: 978-1429202114)

	2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub. (ISBN-10 : 0906923352, ISBN-13 : 978-0906923351) 3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science. (ISBN-10 : 0815344457, ISBN-13 : 978-0815344452) 4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press. (ISBN-10: 9781451117837, ISBN-13: 978-1451117837) 5. Parham, P. (2005). The Immune System. New York: Garland Science. (ISBN-10: 0815345267, ISBN-13: 978-0815345268)

Course Code	**BSE 8XX**
Title of the Course	**M.Sc. Project (Stage I)**
Credit Structure	L-T-P-Credits **0-0-6-3 Credit**
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.
Course Outcome	Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas: ● In-depth knowledge of the chosen area of research. ● Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis. ● Competence in research design and planning. ● Capability to create, analyse and critically evaluate different technical solutions. ● Ability to conduct research independently. ● Ability to perform analytical techniques/experimental methods. ● Project management skills. ● Report writing skills. ● Problem solving skills. ● Communication and interpersonal skills.

2nd Year: Semester–IV

Course Code	**BSE 8XX**
Title of the Course	**M.Sc. Project (Stage II)**
Credit Structure	L-T-P-Credits **0-0-30-15**
Name of the Concerned Department	Department of Biosciences and Biomedical Engineering
Pre–requisite, if any	None
Course Objective	The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.
Course Outcome	Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas: ● In-depth knowledge of the chosen area of research. ● Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis. ● Competence in research design and planning. ● Capability to create, analyse and critically evaluate different technical solutions. ● Ability to conduct research independently. ● Ability to perform analytical techniques/experimental methods. ● Project management skills. ● Report writing skills. ● Problem solving skills. ● Communication and interpersonal skills.