SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Session-2021-22
School of Applied Sciences

M.Sc.
(Biotechnology, Microbiology, Virology & Immunology, Chemistry, Physics)

Post Graduate Programs

Program Outcomes:

PO1: PG Graduands are Professionally Competent with characteristic Knowledge-bank, Skill set, Mind-set and Pragmatic Wisdom in their chosen fields.

PO2: PG Graduands demonstrate the desired sense of being seasoned and exhibit unequivocal Spiritedness with excellent qualities of productive contribution to society and nation in the arena Science and Technology.

PO3: PG Graduands are mentored such that they exert Leadership Latitude in their chosen fields with commitment to novelty and distinction.

PO4: PG Graduands are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining Cultural and Civilized personality.

PO5: PG Graduands get ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.

M.Sc. Microbiology

Program Specific Outcomes:

PSO1: Apply the knowledge of biological, microbial and biochemical fundamentals to find the solution for complex molecular functions and physiology.

PSO2: To train the students in both theory and practical microbiology to accommodate them in both higher education and industries.

PSO3: To augment problem-solving skills of students through industry-oriented training programmes at various levels.

PSO4: To enrich the Graduates with solid fundamentals of microbiology and advanced technologies.

PSO5: To occur hands on skills in Industry and/or Institutes, to better placement

Course Outcomes:

Course code	Course name	Course outcomes
SC 501	Biochemistry	CO.1 Gain fundamental knowledge in biochemistry.
		CO.2 Acquire knowledge on the chemical properties, classification and the biological functions of macromolecules.
		CO.3 Acquire Knowledge of biochemical principles with specific emphasis on different metabolic pathways.
SC 503	Immunology and Immuno-technology	CO.1 Evaluate usefulness of immunology in different pharmaceutical companies
		CO.2 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)
		CO.3 Discuss immunological techniques and their applications in biotechnical industry.
SC 505	Cell and Molecular Biology	CO.1 Recalling the principles and basic mechanisms of metabolic control and molecular signalling
		CO.2 Extending the knowledge and understanding of the molecular machinery of living cells
		CO.3 Applying the knowledge gained through the understanding of Molecular Screening for disease diagnosis
SC 504	Genetics and Microbiology	CO.1 Exploring the role of microbiology in medicine
		CO.2 Skilled at diagnosis of bacterial, viral, protozoan and other parasitic diseases
		CO.3 Learning the concept, etiology and epidemiology of infections
		CO.4 Describe fundamental molecular principles of genetics;
		CO.5 Understand relationship between phenotype and genotype in human genetic traits
SC502	Genetic Engineering and Application	CO.1 Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical and practical knowledge of this technology
		CO.2 Understand the societal concerns and impact of genetically engineered foods and crops
		CO.3 In conjunction with the practical's in molecular biology & genetic engineering, the students should be

		able to take up biological research as well as placement in the relevant biotech industry.
SC 506	Bioinformatics	CO.1 Develop an understanding of basic theory of these computational tools; Critically analyse and interpret results of their study.
		CO.2 Gain working knowledge of these computational tools and methods;
		CO.3 Appreciate their relevance for investigating specific contemporary biological questions
SC 507	Bioanalytical Techniques	CO.1 To be able to use selected analytical techniques
		CO.2 Familiarity with working principals, tools and techniques of analytical techniques
		CO.3 To understand the strengths, limitations and creative use of techniques for problem-solving
SC 508	Research Methodology and Scientific communication Skills	CO.1 Understand history and methodologies of scientific research, applying these to recent published papers.
		CO.2 Understand and practice scientific reading, writing and presentations;
		CO.3 Appreciate scientific ethics through case studies.
SC 605	Biostatistics	CO.1 To create an understanding regarding the tabulation of data – Diagrammatic and Graphical representation of data.
		CO.2 To understand about measures of Central Tendency and their significance in statistics.
		CO.3 To create knowledge about Basics of Probability theory and its applications.
SC 611	Critical Analysis of Classical papers	CO.1 Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.
		CO.2 Understand and practice scientific reading, writing and presentations;
		CO.3 Familiarize students with classic literature to make them appreciate how ground breaking discoveries were made without, necessarily, use of high-end technologies.
SC 613	Basic and applied epidemiology	CO.1 This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment.
		CO.2 Be able to solve the various problems related with Basic and Applied Epidemiology.
		CO.3 Understand the foundations of Basic and Applied Epidemiology.
SC 601	Bioprocess engineering	To provide information about the fundamental concepts of bioprocess technology and its related applications

		Understanding of the various methods to bedeployed for product recovery and applications of various enzymatic processes in the food processing industry.
		Acquire knowledge about the Relevance of microorganisms from industrial context
SC 609	Project Proposal Preparation and Presentation	CO.1 Formulate a scientific question;
		CO.2 Present scientific approach to solve the problem;
		CO.3 Interpret, discuss and communicate scientific results in written form;
		CO.4 Gain experience in writing a scientific proposal;
		CO.5 Learn how to present and explain their research findings to the audience effectively.
SC 602	Dissertation/ Project work	CO.1 Learn hypothesis designing, literature collection and critical reading.
		CO.2 Designing experiments and postulate the expected outcomes.
		CO.3 Perform experiments and critically analyse, Interpret, communicate scientific results in written form.
SC 607	Intellectual Property Rights, Biosafety and Bioethics	CO.1 Acquire insight about different types of intellectual properties, their protection and infringement rules.
		CO.2 Understand the bioethical conflicts in health care, research and biotechnology sector.
		CO.3 Acquire information about the basics of biosafety and various regulations.
SC 640	Virology	CO.1 Learn different techniques in cultivation of viruses.
		CO.2 Understand details about bacterial viruses, animal and plant viruses.
		CO.3 Know various Applications of Viruses in Biotechnology
SC 628	Plant pathogen interaction	CO.1 Distinguish between the different types of plant-microbe interactions.
		CO.2 Explain the physiological and biochemical processes underlying the best characterized plant-microbe interactions.
		CO.3 Draw connections between the biology of plant-microbe relationships and the impacts of these relationships on the ecosystem and human society
SC 638	Microbial physiology and metabolism	CO.1 Understand basic concepts of Microbial physiology and metabolism.
		CO.2 Understand bioenergetics, aerobic respiration and anaerobic respiration.
		CO.3 Know metabolism of carbohydrates, lipids and nucleic acids in Microbes.

SC 630	Environmental microbiology	CO.1 Understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology
		CO.2 Major groups of microorganisms' tools in biotechnology and their most important environmental applications.
		CO.3 Understand concept of aero microbiology, biosafety and waste water management.
SC 642	Microbial pathogenicity	CO.1 Know in details the mechanism of entry of certain pathogens in host cells
		CO.2 Understand details of bacterial, viral, fungal and protozoal diseases as mentioned in the syllabus
		CO.3 Know the ways of controlling infections in hospitals

M.Sc. Biotechnology

Program Specific Outcomes:

PSO1- Development and enhancement of skills required in the Bioprocess industry and medical field.

PSO2- Ability to perform analytical techniques/experimental techniques in industrial scenario for the products recovery aid in the development of new therapeutics as drugs/biobased products.

PSO3- Provoking the analysis of biological data using indifferent approaches based on basic computational and bioinformatics skills.

PSO4-Student will be able to address highly pertinent issues like intellectual property rights (IPR) protection, biosafety and bioethics and also able to work as a team in multidisciplinary facet and competence in research design and planning.

PSO5- Student will be able to of knowledge regarding the designing of new drugs with the help of r DNA technology for curing diseases

Course Outcomes:

Course code	Course name	Course outcomes
SC 501	Biochemistry	CO.1 Acquire the basic understanding of structure and function of different macromolecules.
		CO.2 Understanding of the mechanism of enzyme kinetics and role of different macromolecules in metabolic pathways.
		CO.3 Attain the deep understanding of metabolic pathways of fats, nucleotide and proteins.
SC 503	Immunology and Immuno-technology	CO.1 Acquire in depth knowledge of working mechanism of different types of immune cells involved in immune responses.

		CO.2 Understanding of the detailed mechanism of antigen-antibody interaction reactions.
		CO.3 To provide the information about the concept of vaccines, process of immunization, different types of vaccines and their development timeframe.
		CO.4 To provide understanding of various serological based tests based on different immunological techniques employed in molecular diagnosis.
SC 505	Cell and Molecular Biology	CO.1 Decipher the role of cells as basic building blocks of life.
		CO.2 Deliberately elaborating functionality at an organizational level.
		CO.3 Understand the major role played by constituent organelles including the role of Meiosis and Mitosis.
		CO.4 Analysis of cell cycle and its differential regulation of stages required to develop a cell.
SC 507	Bioanalytical Techniques	CO.1 To create an understanding regarding the technical applications of various tools which are being used in life sciences.
		CO.2 To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
		CO.3 Understand the foundations of Bioanalytical techniques.
SC 504	Genetics and microbiology	CO.1 Acquire the understanding ofbasics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains.
		CO.2 Attain in depth knowledge about concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.
		CO.3 Understanding of structural, physiological, genetic similarities and differences of major categories of microorganisms.
		CO.4 Acquiring information about the various methods to control microbial growth
SC 502	Genetic Engineering and Application	CO.1 Provide In-depth information about tools of genetic engineering and their application in cloning.
		CO.2 Understanding the techniques employed for the gene regulated production of different macromolecules required in medicine on large scales.
		CO.3 Attaining understanding about the mechanism of gene silencing and gene editing for the production of transgenic.
SC 603		CO.1 In-depth information about micro propagation, agar culture and suspension culture in Plants.

	Plant and Animal Biotechnology	CO.2 Attaining understanding about the strategies to be implemented for stem cell and embryonic cultures to develop monoclonal antibodies and therapeutic agents.
		CO.3 Acquisition of the information about the various methods of gene transfer in plant and their regulation.
SC 506	Bioinformatics	CO.1 Develop an understanding of basic concepts of various computational and bioinformatics tools.
		CO.2 Attain understanding of retrieval of information from different databases.
		CO.3 Implementation of strategies to infer the protein secondary structures and modelling of protein.
SC 508	Research Methodology And Scientific Communication Skills	CO.1 To provide in depth knowledge about the concept of research methodology, its importance in scientific communications.
		CO.2 Understand history and methodologies of scientific research, applying these to recent published papers.
		CO.3 Understand and practice scientific reading, writing and presentations and Acquire knowledge about scientific ethics through case studies.
SC 601	Bioprocess Engineering	CO.1 To provide information about the fundamental concepts of bioprocess technology and its related applications.
		CO.2 Understanding of the various methods to be deployed for product recovery and applications of various enzymatic processes in the food processing industry.
		CO.3 Acquire knowledge about the Relevance of microorganisms from industrial context.
SC 611	Critical analysis of classical papers	CO.1 Understanding of the classic literature laying the foundation of current advancements with the advent of high-end technologies.
		CO.2 Acquire in-depth knowledge of various breakthrough discoveries in the field of Developmental biology and genetics.
		CO.3 Understanding the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.
SC 607	Intellectual Property Rights, Biosafety and Bioethics	CO.1 Acquire insight about different types of intellectual properties, their protection and infringement rules.
		CO.2 Understand the bioethical conflicts in health care, research and biotechnology sector.
		CO.3 Acquire information about the basics of biosafety and various regulations.
SC 609	Project Proposal Preparation And Presentation	CO.1 Acquire knowledge about formulation of a scientific question and drafting a scientific proposal.
		CO.2 Understanding of the presentation of scientific approach to solve the problem and explanation of their research findings effectively.

		CO.3 Provide information to organize ideas, material and objectives for their dissertation.
SC 602	Dissertation	CO.1 Knowledge about selection, planning, execution, evaluation, analysis and defence of topic of their research.
		CO.2 In-depth knowledge of the chosen area of research, Competence in research design and planning.
		CO.3 Ability to perform analytical techniques/experimental research independently.
SC 605	Biostatistics	CO.1 To create an understanding regarding the tabulation of data – Diagrammatic and Graphical representation of data.
		CO.2 To understand about measures of Central Tendency and their significance in statistics.
		CO.3 To create knowledge about Basics of Probability theory and its applications.
SC 620	Genomics and Proteomics	CO.1 In-depth information about various strategies of genome mapping
		CO.2 Understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
		CO.3 Understanding the complexities of genome on a very basic level of functional and non-functional genes.
Sc 618	Molecular diagnostics	CO.1 Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
		CO.2 Enabling the student to implement different techniques of detection and testing of different diseases at molecular levels and knowledge about the different biomarkers being employed in oncotherapy
		CO.3 Providing a good experimental experience in the laboratory for resolution detection, nucleic acid extraction and sequence amplification for both DNA and RNA.
SC 628	Emerging technologies	CO.1 Acquire in-depth knowledge of various types of microscopic techniques and their applications
		CO.2 Understanding of the relevance and process of mass spectrometry in drug discovery and structural biology and their potential in therapeutics
		CO.3 Acquire knowledge about the basics of nanobodies and their significance in protein structure function relationship
SC 626	Bio-entrepreneurship and Bio-	CO.1 Acquire the knowledge of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing

	business management	and nurturing the organization and harvesting the rewards.
		CO.2 Understanding of the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies
		CO.3 The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.
SC 604	Nanobiotechnology	CO.1 Acquisition of in-depth knowledge of development of nano biotechnology and methods to synthesise and characterize the nanomaterials
		CO.2 Acquire detailed understanding of applications of nanobiotechnology for the treatment of chronic infection and environmental aspects
		CO.3 In depth knowledge about various detection system based on nanobiotechnology
SC 610	Drug designing and development	CO.1 Understanding of basics of R&D in drug discovery and strategies for target identification, lead optimization and molecular modelling
		CO.2 Knowledge about Implementation of Drug development principles for probable discovery of new drugs
		CO.3 Attain in depth knowledge about ethical issues and regulatory objectives given by regulatory agencies.
SC 612	Advanced clinical biochemistry	CO.1 Acquire the information about the importance and significance of various enzymes in progression of diverse set of diseases.
		CO.2 Understanding of functions of blood and regulation of blood coagulation.
		CO.3 Decipher the wide variety of tests to be employed for diagnosis of various disorders
SC 624	Environmental biotechnology	CO.1 Understanding of biodegradation of naturally occurring compounds
		CO.2 Attain information about the concept and methods of bacteriological analysis of soil and water
		CO.3 Acquire information about the strategies of solid waste management.

M.Sc. Virology & Immunology

Program Specific Outcomes:

PSO1- Students will have fundamental and advanced level knowledge in the field of Virology and Immunology by developing analytic and critical thinking skills through acquired knowledge in these branches.

PSO2-This course forms the basis of science for coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future. These subject areas

include Cell & Molecular Biology, Biochemistry, Immunology and Immuno Technology, Bioanalytical Techniques, genetic engineering, Virological Methods, Bioinformatics, Virus Cell Interaction and Replication, Epidemiology, Biostatistics, IPR, Biosafety and Bioethics.

PSO3- Students will learn the Cell & Molecular Biology, Biochemistry, Immunology and Immuno Technology, Bioanalytical Techniques, genetic engineering, Virological Methods, Bioinformatics, Virus Cell Interaction and Replication, Epidemiology, Biostatistics, IPR, Biosafety and Bioethics to understand and solve the problems of Virology & Immunology.

PSO4-Graduates will develop intellectual curiosity and know how to continue to learn not only areas that are relevant to Virology & Immunology, but also that are important to society.

PSO5- Students will acquire a research-oriented learning that develops analytical and integrative problem-solving approaches.

Course Outcomes

Course code	Course name	Course outcomes
SC509	Basics of Virology	CO.1 To create an understanding regarding the virology.
		CO.2 The student will be able to conceptualize basics of virology.
		CO.3 Understand the foundations of virology.
SC 501	Biochemistry	CO.1 Acquire the basic understanding of structure and function of different macromolecules.
		CO.2 Understanding of the mechanism of enzyme kinetics and role of different macromolecules in metabolic pathways.
		CO.3 Attain the deep understanding of metabolic pathways of fats, nucleotide and proteins.
SC505	Cell and Molecular Biology	CO.1 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.
		CO.2 Be able to solve the various problems related with cell & Molecular Biology.
		CO.3 Understand the foundations of biological molecules and their interaction.
SC 503	Immunology and Immunotechnology	CO.1 To understand the fundamental of Immunology & Immuno-technology.
		CO.2 To have knowledge about Immunology and technology, which can be useful in formulating and solving various issues.
		CO.3 To apply the 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).

SC 613	Basic and applied Epidemiology	CO.1 This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment.
		CO.2 Be able to solve the various problems related with Basic and Applied Epidemiology.
		CO.3 Understand the foundations of Basic and Applied Epidemiology.
SC 510	Virology and Virological Methods	CO.1 To create an understanding regarding the Oncogenic viruses and pathogenesis of cancer.
		CO.2 The student will be able to conceptualize the virological methods.
		CO.3 Understand the fundaments of methods used for virus cultivation, diagnosis, identification, and treatment.
SC 507	Bioanalytical Techniques	CO.1 To create an understanding regarding the technical applications of various tools which are being used in life sciences.
		CO.2 To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
		CO.3 Understand the foundations of Bioanalytical techniques.
SC 502	Genetic engineering and applications	CO.1 Provide In-depth information about tools of genetic engineering and their application in cloning
		CO.2 Understanding the techniques employed for the gene regulated production of different macromolecules required in medicine on large scales.
		CO.3 Attaining understanding about the mechanism of gene silencing and gene editing for the production of transgenic.
SC 615	Virus Cell Interaction and replication	CO.1 To create an understanding regarding the Virus Cell Interaction and Replication.
		CO.2 Be able to solve the various problems related with Research Methodology and Scientific communication Skills.
		CO.3 Understand the foundations of Virus Cell Interaction and Replication.
SC 611	Critical analysis of classical papers	CO.1 Understanding of the classic literature laying the foundation of current advancements with the advent of high-end technologies.
		CO.2 Acquire in-depth knowledge of various breakthrough discoveries in the field of Developmental biology and genetics.
		CO.3 Understanding the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

SC 508	Research Methodology And Scientific Communication Skills	CO.1 To provide in depth knowledge about the concept of research methodology, its importance in scientific communications.
		CO.2 Understand history and methodologies of scientific research, applying these to recent published papers.
		CO.3 Understand and practice scientific reading, writing and presentations and Acquire knowledge about scientific ethics through case studies.
SC 506	Bioinformatics	CO.1 To develop an understanding of basic theory of these computational tools.
		CO.2 To gain working knowledge of these computational tools and methods and appreciate their relevance for investigating specific contemporary biological questions.
		CO.3 Students can critically analyse and interpret results of their study.
SC 605	Biostatistics	CO.1 To create an understanding regarding the tabulation of data – Diagrammatic and Graphical representation of data.
		CO.2 To understand about measures of Central Tendency and their significance in statistics.
		CO.3 To create knowledge about Basics of Probability theory and its applications.
SC 607	Intellectual Property Rights, Biosafety and Bioethics	CO.1 Acquire insight about different types of intellectual properties, their protection and infringement rules.
		CO.2 Understand the bioethical conflicts in health care, research and biotechnology sector.
		CO.3 Acquire information about the basics of biosafety and various regulations.
SC 609	Project Proposal Preparation and Presentation	CO.1 Acquire knowledge about formulation of a scientific question and drafting a scientific proposal.
		CO.2 Understanding of the presentation of scientific approach to solve the problem and explanation of their research findings effectively.
		CO.3 Provide information to organize ideas, material and objectives for their dissertation.
SC 602	Dissertation	CO.1 Knowledge about selection, planning, execution, evaluation, analysis and defence of topic of their research.
		CO.2 In-depth knowledge of the chosen area of research, Competence in research design and planning.
		CO.3 Ability to perform analytical techniques/experimental research independently.
SC 642	Vector biology	CO.1 To create an understanding regarding the vector biology

		CO.2 To describe individual components of vector biology using specific examples
		CO.3 Demonstrate how vector biology is integral to our public health history, philosophy and values and identify.
SC 636	Antivirals and vaccine development	CO.1 Have a deep understanding of Antivirals and Vaccine Development.
		CO.2 Be able to solve the various problems on Antivirals and Vaccine Development.
		CO.3 Understand the foundations of Antivirals and Vaccine Development.
SC644	Virus diseases and cancer	CO.1 Have a deep understanding of Viral Diseases and Cancer.
		CO.2 Be able to solve the various problems on Viral Diseases and Cancer.
		CO.3 Understand the foundations of Viral Diseases and Cancer.

M.Sc. Chemistry

Program Specific Outcomes:

PSO1- Students will learn the synthesis and analytical methods to solve problems of Chemistry.

PSO2- Students will have fundamental and advanced level knowledge in the field of organic, inorganic, physical and analytical chemistry and critical thinking skills through acquired knowledge in these branches of chemistry.

PSO3-Graduates will learn to apply various aspects of chemistry in natural products isolations, pharmaceuticals, dyes, textiles, polymers, petroleum products, forensic etc. and also to develop interdisciplinary approach of the subject

PSO4-Appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments

PSO5-Students will understand the background of organic reaction mechanisms, complex chemical structures, instrumental method of chemical analysis, molecular rearrangements and separation techniques.

Course Outcomes:

Course code	Course name	Course outcomes
SC 511	Quantum Mechanics, Symmetry & Group Theory	CO.1 Have a deep understanding of Postulates of Quantum
		CO.2 Be able to solve the Mechanics Schrödinger wave equation for single and multi-electron system

		CO.3 Understand the concept of Molecular Symmetry and point groups for various industrially important compounds
SC 513	Thermodynamics & Surface Chemistry	CO.1 Have a deep understanding of the law of thermodynamics and their applications
		CO.2 Be able to learn the Statistical Method, Boltzmann distribution and its utility
		CO.3 Understanding adsorption theories and to apply for determination of surface area of solids
SC 515	Analytical Techniques	CO.1 To Know the principle of atomic absorption and atomic spectrometry
		CO.2 Have knowledge about separation methods like solvent extraction, chromatography etc.
		CO.3 Students will have Knowledge about the principle, instrumentation and applications of polarography
SC 517	Advanced Organic Chemistry-I	CO.1 Know the basic principles of UV, IR and NMR spectroscopy and their application to identify of simple organic compounds.
		CO.2 Understand various aspects of disconnection approach to know the order of events in organic synthesis and chemoselectivity
		CO.3 Be able to make, catalysis in petrochemical processes
SC 519	Coordination Chemistry	CO.1 Have a deep understanding of Structure, Bonding and Properties of Transition Metal Complexes
		CO.2 Be able to correlate Jahn- Teller distortion with the spectral and magnetic properties of coordinated complexes
		CO.3 Students will be able to apply Molecular Orbital Theory (MOT) of Coordination Compounds for understanding of their magnetic properties
SC 702	Organometallic Chemistry	CO.1 Know fundamental aspects of synthetic methods, reactivity and bonding in Main Group Organometallics
		CO.2 Have knowledge about structure and Bonding in Organometallic Compounds .
		CO.3 Understanding of concept of hapticity, transition metal complexes of alkenes, structure and properties of Ziese salt
SC 704	Kinetics and Photochemistry	CO.1 Have a phenomenological understanding of Arrhenius equation and its application for theoretical calculation of energy of activation
		CO.2 To know the kinetics of various types of reactions and kinetics solvent effect, kinetic isotope effect and salt effect
		CO.3 Be able to know photochemistry of carbonyl compounds – Norrish Type I and Norrish Type II
SC 706	Adv. Organic Chemistry-II	CO.1 Understanding of Conformation and Chemical Reactivity I

		CO.2 Students Will learn types of Reactions, importance of product analysis, reactive intermediates and their detection
		CO.3 Knowing of FMO approach, Woodward-Hoffman correlation diagram method, pericyclic reactions under thermal and photochemical conditions
SC 708	Electroanalytical Chemistry	CO.1 Have a deep understanding of Basics of Polarography
		CO.2 Be able to know characteristics commonly used working electrodes such as glassy carbon, platinum, pyrolytic graphite and reference electrodes SCE and Ag/AgCl
		CO.3 Understand the fundamentals of Voltametric Techniques
SC 710	Enantiomeric Separation	CO.1 Have a deep understanding of Modern stereochemical concepts
		CO.2 Be able to know the Techniques used for studies of optically active compounds
		CO.3 Understand the basic chromatographic theory and instrumentation of gas and liquid chromatography
SC 711	Heterocyclic Chemistry	CO.1 Have a deep understanding of mechanism of reaction for the preparation of heterocycles
		CO.2 Be able to developed conceptual schematics required for heterocyclic chemistry
		CO.3 Understand the reactivity of benzofurans (coumarins), benzothiophenes, dibenzofurans and dibenzothiophenes.
SC 713	Molecular Spectroscopy	CO.1 Have a deep understanding of different aspects of molecular spectroscopy
		CO.2 Be able to interpret the spectra obtained from various spectroscopic techniques
		CO.3 Understand of characterization of organic compounds using NMR, UV, Mass, ESR and IR techniques
SC 715	Advanced Analytical Chemistry I	CO.1 Have a deep understanding of principle, instrumentation and applications of electroanalytical methods
		CO.2 Be able to know the X-ray spectra, x-ray absorption, emission, fluorescence and diffraction methods for characterization of compounds
		CO.3 Understand of ion sensors, semipermeable membranes and selectivity
SC 712	Dissertation/ Project work	CO.1 Knowledge about selection, planning, execution, evaluation, analysis and defence of topic of their research.
		CO.2 In-depth knowledge of the chosen area of research, Competence in research design and planning.

		CO.3 Ability to perform analytical techniques/experimental research independently.

M.Sc. Physics

Program Specific Outcomes:

PSO1- Students will have fundamental and advanced level knowledge in the field of Classical and Quantum mechanics by developing analytic and critical thinking skills through acquired knowledge in these branches of physics.

PSO2-Students will learn the mathematical and statistical methods to solve problems of Physics.

PSO3-Graduates will develop intellectual curiosity and know how to continue to learn not only areas that are relevant to Physics, but also that are important to society. Students will acquire a research-oriented learning that develops analytical and integrative problem-solving approaches.

Course Outcomes:

Course code	Course name	Course outcomes
SC 521	Classical Mechanics	CO.1 Have a deep understanding of Newton's laws.
		CO.2 Be able to solve the Newton equations for simple configurations using various methods.
		CO.3 Understand the foundations of chaotic motion.
SC 523	Quantum Mechanics	CO.1 Have a deep understanding of the mathematical foundations of quantum mechanics.
		CO.2 Be able to solve the Schrödinger equation for simple configurations.
		CO.3 Understanding to apply Quantum concepts to several applications
SC 804	Condensed Matter Physics	CO.1 Know fundamental laws of physics of atoms and molecules.
		CO.2 Have knowledge about connections between physics of atoms and molecules and chemistry, which can be useful in formulating and solving engineering issues.
		CO.3 Have knowledge in the field of electrodynamics, quantum mechanics and physics of atoms and molecules.
SC 811	Nuclear and Particle Physics - I	CO.1 Know the basic properties of nucleus and nuclear models to study the nuclear structure properties.
		CO.2 Understand various aspects of nuclear reactions will give idea how nuclear power can be generated.
		CO.3 Be able to make quantitative estimates of phenomena involving nuclei.
SC 527	Statistical Mechanics	CO.1 Have a deep understanding of physical statistics and its relation to information theory.
		CO.2 Be able to solve statistical mechanics problems for simple non-interacting systems.

		CO.3 Be able to use linear response theory and kinetic equation approach
SC 808	Atomic & Molecular Physics	CO.1 Know fundamental laws of physics of atoms and molecules.
		CO.2 Have knowledge about connections between physics of atoms and molecules and chemistry, which can be useful in formulating and solving engineering issues.
		CO.3 Have knowledge in the field of electrodynamics, quantum mechanics and physics of atoms and molecules.
SC 802	Electrodynamics and electromagnetic theory	CO.1 Describe the physical concepts of static magnetic fields
		CO.2 Apply the maxwell equations to solve problems in electromagnetic field theory
		CO.3 Analyse the propagation of wave in different media
SC 812	Dissertation/ Project work	CO.1 Knowledge about selection, planning, execution, evaluation, analysis and defence of topic of their research.
		CO.2 In-depth knowledge of the chosen area of research, Competence in research design and planning.
		CO.3 Ability to perform analytical techniques/experimental research independently.
SC 814	IPR	CO.1 Acquire insight about different types of intellectual properties, their protection and infringement rules.
		CO.2 Understand the bioethical conflicts in health care, research and biotechnology sector.
		CO.3 Acquire information about the basics of biosafety and various regulations.
SC 806	Advanced Electronics	CO.1 Have a deep understanding of electronic devices.
		CO.2 Be able to solve the equations for simple configurations using various methods.
		CO.3 Understand the foundations of electronic principle and applications.
SC 813	Experimental Techniques of Physics	CO.1 Have a deep understanding of error analysis, experimental criteria and characteristics.
		CO.2 Be able to understand the important experimental parameters.
		CO.3 Understand the various experimental devices and systems.
SC 525	Mathematical Physics	CO.1 Have a deep understanding of theorems and mathematical techniques.
		CO.2 Be able to solve the equations for simple configurations using various methods.
		CO.3 Understand the foundations of mathematical concepts and their applications in physics.

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

SYLLABUS

M.Sc. CHEMISTRY
SCHOOL OF APPLIED SCIENCES

Session 2021-23

M.Sc. Chemistry

1. Need objectives and main features of curriculum

Curriculums of M.Sc. Chemistry are designed to provide chemist, technologist, and a good Researcher to the science world & society at large. .It would not only provide an understanding but would also add on to their knowledge. The application of various tool and techniques in the field of chemistry/technology. The objective of designing this curriculum for the student is to update student's knowledge about:

1. Living system and their interaction with technology to generate things of mankind.
2. Encouraging students to develop intellectual independence, critical thinking skills and versatility.
3. Principles of various conventional and specialized laboratory investigations and instrumentation, analysis and interpretation of a given data; the ability to suggest experiments to support theoretical concepts and clinical diagnosis.
4. Molecular mechanisms of gene expression and regulation, the principles of genetic engineering and their application in medicine, agriculture, environment and food industries.
5. Chemical basis of environmental health hazards and their remedial process
6. To optimally focus resources for R&D in chemical sciences.
7. To create centers of excellence as high quality support services to chemical industries.
8. To promote the field of bioinformatics.
9. To suitably address highly pertinent issues like intellectual property rights (IPR) protection, safety and ethics.

2. Role of curriculum in national development

Chemical science has an important role to play in future social and economic well-being, on a national and international scale. It can lead to major following benefits:

1. Advances in agriculture and crop technology can help fight world starving population.
2. Innovations in food and nutritional science can lead to everyday improvements in health and hygiene.
3. Innovative technology can boost the leading role of Indian commerce specially food & dairy, pharmaceutical, agriculture and FMCG.
4. Producing things using chemical approaches and contributing towards national economy and GDP

3. Global trends reflecting in the curriculum

The profession of scientist has pious mandatory duty to undertake research and develop new products using chemical approaches, in various field of chemical science which attribute to human welfare ,directly or indirectly . The current science is rapidly advancing by the efforts of the chemist,. Present course have been developed to educate the student not only about the advancement in the field of biosciences but also to give them exposure of these requisites.

4. Possibility, motivation and scope for self learning

Knowledge of chemical sciences helps identity various areas where the application of spectroscopic technique could be utilized. The products like new drugs, diseases diagnostic kits, pesticides etc. could be generated in the benefit of mankind and society. This field need good level scientific input from scientists trained across various disciplines including analytical chemistry, clinical chemistry, Nano-technology, chemical process technology etc.

5. Placement opportunities

A wide range of career opportunities are available for students of chemical science. There are numerous opening available to choose from one they have attained education. Those include: Agriculture, Agrochemical Companies, Clinical and Forensic Science Laboratories, Corporate Firms, Food /Beverages Industries, Hospitals, Pharmaceutical Industry, Research and Educational Institutions, Clinical Research, Management, Manufacturing, Marketing, Quality Control, Information Science, Technical Writing and Editing. Besides this students can also opt for teaching in the respective field.

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

Academic year: 2021-23 Program

School of Applied Sciences **Program: M.Sc. Chemistry: Semester: I**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	PC-501	**Proficiency in Co-Curricular Activity**	University Core	2	0	0	0		100	
2.	SC 511	**Quantum Mechanics, Symmetry & Group Theory**	Program Core	3	3	0	0	3	40	60
3.	SC 513	**Thermodynamics & Surface Chemistry**	Program Core	3	3	0	0	3	40	60
4.	SC 515	**Analytical Techniques**	Program Core	3	3	0	0	3	40	60
5.	SC 517	**Advanced Organic Chemistry-I**	Program Core	3	3	0	0	3	40	60
6.	SC 519	**Coordination Chemistry**	Program Core	3	2	0	0	3	40	60
7.	SC 559	**Advanced Laboratory-I**	Program Core	6	0	0	12	12	60	40
8.	SC 561	**Minor Project -I**	Program Core	3	0	0	3	3	60	40
9.	SC 563	**Seminar–I**	Program Core	1	0	2			60	40
		Total		**27**	**14**	**2**	**15**			

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

Academic year: 2021-23 Program

School of Applied Sciences **Program: M.Sc. Chemistry: Semester: II**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-502	**Employability Skills I**	University Core	1	1	0	0	3	60	40
2.	PC-502	**Proficiency in Co-Curricular Activity**	University Core	2	0	0	0	0	100	
3.	SC 702	**Organometallic Chemistry**	Program Core	3	3	0	0	3	40	60
4.	SC 704	**Kinetics and Photochemistry**	Program Core	3	3	0	0	3	40	60
5.	SC 706	**Adv. Organic Chemistry-II**	Program Core	3	3	0	0	3	40	60
6.	SC 708	**Electroanalytical Chemistry**	Program Core	3	3	0	0	3	40	60
7.	SC 710	**Enantiomeric Separation**	Program Core	3	3	0	0	3	40	60
8.	SC 752	**Advanced Laboratory-II**	Program Core	6		0	12	12	40	60
9.	SC 754	**Seminar–II**	Program Core	1	0	2	0	2	40	60
10.	SC 756	**Minor Project –II**	Program Core	1	2	0	3	3	60	40
11.	SC 758	**Industrial Training**	Program Core	2	0	0	3		60	40
		Total		**28**	**18**	**2**	**18**			

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme
Academic year: 2021-23 Program
School of Applied Sciences Program: M.Sc. Chemistry: Semester: III

S.No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-601	**Employability Skills II**	University Core	1	1	0	0	3	60	40
2.	PC-601	**Proficiency in Co- Curricular Activity**	University Core	2	0	0	0		100	
3.	SC 711	**Heterocyclic Chemistry**	Program Core	3	3	0	0	3	40	60
4.	SC 713	**Molecular Spectroscopy**	Program Core	3	3	0	0	3	40	60
5.	SC 715	**Advanced Analytical Chemistry I**	Program Core	3	3	0	0	3	40	60
6.	-	**Elective I**	Program Core	3	3	0	0	3	40	60
7.	-	**Elective –II**	Program Core	3	3	0	0	3	40	60
8.	SC 761	**Practical-III**	Program Core	6		0	12	12	40	60
9.	SC 763	**Minor Project –III**	Program Core	3	0	0	3	3	60	40
10.	SC 765	**Seminar–III**	Program Core	1	0	2	0	2	60	40
		Total		**26**	**16**	**2**	**15**			

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective paper

1.	**Advanced Analytical Chemistry II**	MCY 607
2.	**Inorganic Biochemistry and Reaction Mechanism**	MCY 609
3.	**Solid-State Chemistry and its Applications**	MCY 611
4.	**Advanced Organic Chemistry- I**	MCY 613

5.	**Advanced Organic Chemistry II**	MCY 615
6.	**Advanced Physical Chemistry - I**	MCY 617
7.	**Advanced Physical Chemistry - II**	MCY 619
8.	**Asymmetric Synthesis**	MCY 621

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

Academic year: 2021-23 Program

School of Applied Sciences Program: M.Sc. Chemistry: Semester: IV

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1	SC 712	**Dissertation/ Project work**	Program Core	20			0	3		100
		Total		20	0	0	0			

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SC 511	**Quantum Mechanics, Symmetry & Group Theory**
Version	**1.0**
Pre-requisite:	Basics of Quantum Mechanics, Symmetry & Group Theory
Objective:	To provide basic concepts and mathematical treatment of atomic model, chemical bond, symmetry and group theory.
Expected Outcome:	Developed conceptual schematics required for quantum mechanics and an ability to translate pertinent criteria into system requirements
Unit-I	**Quantum Mechanics I**:
Postulates of Quantum Mechanics, observables, operators, functions, Schrödinger wave equation, hydrogen atom, transformation of coordinates, separation of variables, The φ equation, The Θ equation, The radial equation, quantum states, the electron spin, energy states of hydrogen atom, wave functions of hydrogen atom, radial distribution curves and angular dependence of wavefunction, graphical representation of orbitals, Multielectron systems	
Unit- II	**Quantum Mechanics II:**
Term Symbols, Introduction to approximation methods, Theories for chemical bonding.	
Unit-III	**Molecular Symmetry**
Symmetry elements and symmetry operations, symmetry elements and optical isomerism, symmetry point groups, various steps to identify point groups of molecular species and some illustrative examples, classes of symmetry operation	
Unit-IV	**Group Theory:**
Representation of a group, the great orthogonality theorem and its consequences, character tables, representation for cyclic groups, the direct product, reducible and irreducible representations, analysis of reducible representations, reducible representations for molecular motions and its analysis	
Unit-V	**Applications of Group Theory:**
Group theory and Quantum mechanics . vanishing integrals , orbital overlap, symmetry adapted linear combinations, molecular shapes, symmetry of normal modes of vibrations, prediction o f infrared and Raman activity, electronic transitions	
Reference books	1. Simons J. and Nichols J., "Quantum Mechanics in Chemistry. Oxford University Press 2. Levine I. R., "Quantum Chemistry" Pearson Education, Inc. 3. Szabo A., and Ostlund N. S. "Modern Quantum Chemistry" Tata McGraw Hill 4. Cotton F. A., Chemical Applications of Group Theory" Wiley
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 513	**Thermodynamics & Surface Chemistry**
Version	I
Prerequisite	All students are expected to have a general knowledge of Thermodynamics and surface chemistry..
Learning objective	● To familiarize students with thermodynamics aspects of chemical equilibria, ● Phase equilibria, ● Urface process and ionic systems
Expected Outcome	Developed conceptual schematics required for quantum mechanics and an ability to translate pertinent criteria into system requirements
Unit-I	**Laws of Thermodynamics:**
Third law of thermodynamics, Nernst theorem, attainability of absolute zero, the thermodynamic treatment of phase equilibria, thermodynamic properties of solutions, chemical potential, chemical potential of real gases	
Unit- II	**Fugacity and thermodynamics**
, thermodynamic function of mixing, thermodynamic treatment of ideal and non-ideal solutions, concept of activity, excess thermodynamic functions.	
Unit-III	**Statistical Mechanics:**
Statistical Method, probability of distribution and ensembles, Microcanonical ensemble, entropy and probability, Canonical ensemble, Boltzmann distribution, partition function and their evaluation and relation with thermodynamic properties, evaluation of entropy of gasses by statistical method, Grand Canonical ensemble and other ensembles: partition function	
Unit-IV	**Surface Chemistry:**
Surface phenomenon, electrical phenomenon of interphases, adsorption of gases by solids, type of adsorption, BET theorem, determination of surface area of solids, adsorption from solution.	
Unit-V	**Thermodynamics of Ionic Systems:**
Thermodynamics of reversible and irreversible electrochemical systems, thermodynamic foundation of theory of ionic interaction and calculation of energy of ionic interaction, interpretation of electrical conductance of electrolytes, thermodynamic treatment of diffusion potential. Thermodynamics of different types of chemical processes accounting in living systems, metabolic and biosynthetic reaction.	
Reference books	1. Atkins P.W., "Physical Chemistry", 7th Edition, ELBS, Oxford University Press. 2003 2. Silbey R.J. and Alberty R.A., "Physical Chemistry", 4th Edition, John Wiley & Sons, Inc., New York. 2003 3. Mc Quarie, D. A., "Statistical Mechanics" Viva Books Pvt. Ltd, 2003
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 515	Analytical Techniques
Version	I
Prerequisite	All students are expected to have knowledge of Analytical Techniques
Learning objective	To impart the fundamental knowledge of different analytical methods
Expected Outcome	Developed conceptual schematics required for Analytical Techniques and an ability to translate pertinent criteria into system requirements
Unit-I	**Atomic spectrometry**:
Principle of atomic absorption and atomic spectrometry, instrumentation, Atomic fluorescence spectrometry	
Unit- II	**Separation methods**:
Solvent extraction: Partition law and its limitations, distribution ratio, separation factor, factor influencing extraction, multiple extractions.	
Unit III	**Chromatography:**
theory of column chromatography, retention time, retention value, capacity factor, concept of plate and rate theory, resolution, column performance, paper and thin layer chromatography, Ion exchangers	
Unit-IV	**Electroanalytical methods**:
Polarography – principle, instrumentation, limitations, applications to qualitative and quantitative analysis, Ameperometric and Bioamperometric titrations	
Unit-V	**Nuclear methods**:
Concept of radiotracers and radiolabelling, radioisotope production and their properties, radioactivity and radiation measurement, activation analysis, isotope dilution method.	
Reference books	1. Sood, D.D., Reddy A.V.R. and Ramamoorthy N., (2004) " Fundamentals of Radiochemistry", Indian Association of Nuclear Chemists and Allied\ Scientists, BARC, Mumbai 2. Mendham J., Denny R.C., Barnes J.D. and Thomas M.J.K., (2004) "Vogel's Text Book of Quantitative Chemical Analysis" 6th Ed., Pearson Education 3. Skoog, D.A., West D.M., Holler F.J. and Crouch S.R., (2004) " Fundamentals of Analytical Chemistry" 8th Edition, Thomson Brooks/Cole. 4. Fifield F.W., and Kealey D., (2000) "Principles and Practice of Analytical Chemistry", 5th Ed., Blackwell Science. 5. Ewing G.W., (2004) "Instrumental Methodsof Chemical Analysis", 5th Ed., McGraw Hill.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 517	**Advanced Organic Chemistry-I**
Version	I
Prerequisite	All students are expected to have a basic concept of Organic Chemistry and organometallics.
Learning objective	The learning objective of course are to introduce field of organic chemistry with special emphasis on spectroscopy, disconnection approach, organometallic compounds, organo silicon and sulphur.
Expected Outcome	The student will be able to conceptualize about ● Identify types of spectroscopy and their classification ● Identify and demonstrate structural, characterization of compounds ● To know the mechanism of reaction
Unit-I	**Spectroscopy**
General introduction to UV, IR and NMR spectroscopy their application\ to identification of simple organic compounds. Shifts of bands with solvents, isolated and conjugated double bonds, Woodward – Fieser rules, polyenes, carbonyl compounds, aromatic systems. Stereochemical non-equivalence – diastereotopic and enantiotopic protons, use of deuterium oxide to identify exchangeable hydrogens	
Unit- II	**Disconnection Approach:**
Synthons and synthetic equivalents, definitions, guidelines, functional group interconversions, use of acetylenes and aliphatic nitrocompounds in organic synthesis; two-group C-C disconnections – Diels-Alder reaction, 1,3- & 1,5- difunctional compounds (Michael addition & Robinson annulation); order of events in organic synthesis, chemoselectivity, reversal of polarity (umpolung), cyclisation reactions, and amine synthesis.	
Unit-III	**Organometallic compounds**
Transition metals-mediated reactions: Organocopper intermediates; reactions involving organopalladium intermediates – palladium-catalyzed nucleophilic substitution and alkylation, Heck reaction, palladium-catalyzed cross coupling, and carbonylation reactions; reactions involving organonickel compounds; reactions Carbon-carbon bond-forming reactions of compounds of boron, and tin: Synthesis and C-C bond-forming reactions of organoboron, and organotin compounds.	
Unit-IV	**Organo silicon- and sulphur chemistry Silicon**
Silicon and carbon compared, silicon Baeyer-Villiger rearrangement, nucleophilic substitution at silicon, silyl ethers and alkyl silanes as protecting groups, aryl and vinyl silanes, migration of silicon from carbon to oxygen. **Sulphur:** Sulphur stabilized anions, thioacetals, allyl sulphides, sulphonium salts, sulphonium ylids, sulphur stabilized cations, chiral sulphoxides in synthesis.	
Unit-V	**Introduction to petrochemicals:**
First generation of petrochemicals, second generation of petrochemicals, third generation of petrochemicals, catalysis in petrochemical processes, future of petrochemicals.	

Reference books	1. Morrison R.T. and Boyd R.N., (2001) "Organic Chemistry", 6th Ed., Prentice Hall of India. 2. Solomons T.W.G. and Fryhle C.B., (2001) "Organic Chemistry", 8th Ed., Wiley Inc. 3. Silverstein R.M. and Webster F.X., (2001) "Spectroscopic Identification of Organic Compounds", 6th Ed., Wiley Inc. 4. Pavia D.L., Lampman G.M. and Kriz G.S., (2001) "Introduction to Spectroscopy", 3rd Ed., Harcourt Inc. 5. Maiti S., (2001) "Introduction to petrochemicals", 2nd Ed., Oxford & IBH.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 559	**Advanced Laboratory-I**
Version	I
Prerequisite	All students are expected to have a general knowledge of Basics of Advanced Laboratory-I
Learning objective	To introduce students with the organic, inorganic and physical chemistry experiments.
Expected Outcome	The student will be able to conceptualize about: ● Developed advanced laboratory experiments and an ability to translate pertinent criteria into system requirements ● Simple synthesis of organic compounds ● Estimation of metal ions by gravimetric-cum-volumetric analysis

Unit	Content
1.	**Organic Chemistry** Exp. Involving crystallization/ distillation/ purification, e.g: (i) Phthalic acid from hot water (ii) Naphthalene form ethanol. Simple synthesis of organic compounds, e.g.: (i) p-nitracetanilide, (ii) p-nitroaniline, (iii) p-amino azobenzene, (iv) adipic acid from cyclohexene (vii) cinnamic acid from benzaldehyde. Estimations of organic functional groups, e.g. : (i) glucose (ii) phenol (iii) glycine etc. Separation techniques: (TLC, column chrom., UV-Vis), e.g, (i) Determine R_f values and purity of organic compounds using TLC Separate a binary mixture of organic compounds using column chromatography.
2.	**Inorganic Chemistry** Semi-micro qualitative analysis involving 8 radicals including interfering radicals. Estimation of metal ions by gravimetric-cum-volumetric analysis: (i) Ag (I) gravimetrically and Cu(II) volumetrically (ii) Cu(II) gravimetrically and Zn(II) volumetrically (iii) Fe(III) gravimetrically and Ca(II) volumetrically. Gravimetric analysis of a mixture of two metal ions. Synthesis of simple coordination compounds: Chrome alum, tetraamine copper(II) sulphate, $Fe(acac)_3$ and $Mn(acac)_3$.
3.	**Physical Chemistry** Viscometry: Measurement of viscosity of solutions of a polymer, and calculation of average molecular weight of a polymer. Determination of standard reduction potential of Cu/Cu^{2+} and Zn/Zn^{2+} electrodes. Determination of pk_1 and pk_2 of dibasic acids. Kinetics of saponification of an ester. Determination of specific and molar rotation of sucrose solution using polarimeter. To study the kinetics of H^+-catalysed hydrolysis of sucrose using polarimeter. Verification of Freundlich adsorption isotherm and Langmuir adsorption isotherm. Study of oscillatory reactions. Determination of the equilibrium constant for $Kl+l_2 = Kl_3$ reaction using partition method. Determination of the dimerization constant of Acetic acid/benzoic acid. Study of variation of angle of rotation with concentration of sucrose/tartaric acid using polarimetry. To determine the velocity constant for the saponification of ethyl acetate, using the conductance method at 30^0C. Determine the fluorescence quantum yield of the given substance.

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 519	**Coordination Chemistry**
Version	I
Prerequisite	All students are expected to have a general knowledge of Basics of coordination chemistry
Learning objective	The objective of this course is to give conceptual exposure of basic and advanced concepts of coordination chemistry
Expected Outcome	The student will be able to conceptualize about ● Scope of coordination compounds ● Stereochemical Aspects of Coordination Complexes ● Metal-Ligand Bonding ● Electronic Spectra of Coordination Compounds

Unit-I	**Structure, Bonding and Properties of Transition Metal Complexes**:
Different types of ligands and coordination geometry (symmetry considerations), coordination number, isomerism (recapitulation), HSAB concept, thermodynamic stability, successive and overall stability constants, determination of stoichiometry (Job's method) and stability constants by spectrophotometric, potentiometric and polarographic methods, Irving-William series, chelate and macrocyclic effect.	
Unit- II	**Stereochemical Aspects of Coordination Complexes**
Stereoisomerism in inorganic complexes, isomerism arising out of ligand and ligand conformation, chirality and nomenclature of chiral complexes, optical rotatory dispersion (ORD) and circular dichroism (CD).	
Unit-III	**Metal-Ligand Bonding**
Overview of crystal field and ligand field theories of 4-, 5- and 6-coordinated complexes, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral, square pyramidal, trigonal-bipyramidal and cubic complexes, measurement of CFSE (d^1 to d^{10}) in weak and strong ligand fields, Jahn- Teller distortion, nephelauxetic series, variation of lattice energy, ionic radii and heat of hydration across 1st row transition metal ions	
Unit-IV	**Molecular Orbital Theory (MOT) of Coordination Compounds**:
Composition of ligand group orbitals, molecular orbital energy diagrams of octahedral, tetrahedral, square planar complexes including both σ and π bonding, angular overlap model. **Electronic Spectra of Coordination Compounds:** Energy states from spectral terms of d^n configurations, selection rules for ligand-field and charge transfer transitions in metal complexes, band intensities, factors influencing band widths, splitting of various terms, Orgel and Tanabe-Sugano diagrams of octahedral and tetrahedral d^n complexes, calculation of ligand field parameters, luminescence, phosphorescent complexes.	
Unit-V	**Molecular Magnetism and Magnetic Properties of Coordination Compounds**
Fundamental equations in molecular magnetism, magnetic susceptibility and magnetic moment, diamagnetic and paramagnetic behavior of transition metal complexes, spin-orbit coupling effects (L-S coupling and j-j coupling), orbital angular moment and its quenching in octahedral and tetrahedral complexes, temperature independent paramagnetism (TIP) of complexes, spin cross over phenomenon, spin admixed states, metal-metal direct spin interaction and super exchange spin-spin interaction through bridging ligands, ferromagnetic, anti-ferromagnetic, ferromagnetic behaviour of transition metal compounds, molecule based magnetic materials.	
Reference books	1. Cotton, F.A., Wilkinson, G., Murillo, C.A., Bochmann M., (**1999)** "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons. 2. Douglas, B.E., McDaniel, D.H., Alexander, J.J., (**2001)** "Concepts and Models in Inorganic Chemistry", 3rd Ed., John Wiley & Sons. 3. Figgis, B.N., Hitchman, M.A (**1999)** "Ligand Field Theory and Its Applications", Wiley Eastern Ltd. 4. Huheey, J.E., Keiter, E.A., Keiter, R.L., **(2003)** "Inorganic Chemistry Principle of Structure and Reactivity", 4th Ed, Pearson Education, Inc 5. Atkins, P., Overton, T., Rourke, J., Mark, W., Armstrong, F., "Shriver and Atkins' (2009) Inorganic Chemistry", 4th Ed, Oxford university press. 6. Lee, J.D., " Concise Inorganic Chemistry", (**1999)** 5th Ed, Blackwell Science Ltd.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 702	**Organometallic Chemistry**
Version	I
Prerequisite	All students are expected to have a general and basic knowledge of organometallic Chemistry .

Learning Objective	To impart basic and advanced concepts in organometallic chemistry
Expected Outcome	Developed conceptual schematics required coordination chemistry for and an ability to translate pertinent criteria into system requirements
Unit-I	**Main Group Organometallics**
Introduction, review of comparative aspects of synthetic methods, reactivity and bonding in ionic, covalent, electron deficient and electron rich organometallic compounds.	
Unit- II	**Important Reactions of Organometallics**
Kinetics and mechanism of ligand substitution (associative and dissociative), oxidative addition and reductive elimination, transmetallation, migratory insertions, reactivity at metal-bound ligands.	
Unit-III	**Structure and Bonding in Organometallic Compounds**
Introduction, 18 electron rule and its application to π-acceptor ligands, limitations of 18 electron rule, description of bonding models for π-acceptor ligands, including CO, alkenes (Dewar-Chatt-Duncanson model) and tertiary phosphines, physical evidence and consequences of bonding.sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	
Unit-IV	**Organotransition Metal Chemistry**
σ-Bonded transition metal-alkyls, - aryls, - alkenyls(vinyls), -alkynyls(acetylides), reactions in σ–organyls: homolytic cleavage, reductive elimination, electrophilic cleavage, insertion, β-metal hydrogen elimination, α-abstraction or α-elimination.	
Unit-V	**Organotransition Compounds with Multicenter Bonds (non-classically bonded):**
Concept of hapticity, transition metal complexes of alkenes, Ziese salt, allenes, alkynes, allyls, butadienes; cyclic π-metal complexes cyclobutadienes, cyclopentadienyls, arenes, cycloheptatrienyls and cyclooctatetraenes; reactions and bonding in ferrocene; stereochemical non-rigidity in organometallic compounds and fluxional compounds, bimetallic and cluster complexes.	
Reference books	1. Huheey, J.E., Keiter, E.A., Keiter, R.L., **(2003)** "Inorganic Chemistry Principle of Structure and Reactivity", 4th Ed, Pearson Education Inc. 2. Douglas, B.E., McDaniel, D.H., Alexander, J.J., **(2001)** "Concepts and Models in Inorganic Chemistry", 3rd Ed., John Wiley & Sons. 3. Hill, A.F., **(2002)** "Organotransition Chemistry", The Royal Society of Chemistry, Cambridge. 4. Bochmann, M. (Ed.), **(2002)** "Oxford Premier Series on Organometallics", Vol. 1 and 2. Oxford Press. 5. Gupta, B.D., Elias, A.J., **(2013)** "Basic Organometallic Chemistry", 2nd Ed., University press (India) Pvt Ltd
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 704	**Kinetics and Photochemistry**
Version	I
Prerequisite	All students are expected to have a general knowledge of Kinetics and Photochemistry.
Learning objective	The objectives of this course are to provide theory and practical experience of theuse of common computational tools and databases which facilitate investigation of Kinetics and Photochemistry
Expected Outcome	The student will be able to conceptualize about ● Develop an understanding of basic theory of Reaction Dynamics; ● Gain knowledge of kinetics of reactions ; ● Appreciate their relevance for investigating specific contemporary photochemical questions; ● Critically analyse and interpret results of their study.
Unit-I	**Reaction Dynamics**
Arrhenius equation, the concept of activation energy, theoretical calculation of energy of activation using potential energy surface diagram, simple collision theory, absolute reaction rate theory, comparison between gas phase and solution reactions.	
Unit- II	**Type of reactions**
Kinetics of chain reactions, detections of radical and kinetics of HBr, H_2O_2 reactions, explosion limits, elementary idea of unimolecular reactions, application of following to the reaction kinetics solvent effect, kinetic isotope effect and salt effect, experimental technique for studying the fast reaction kinetics, kinetics of acid, base and enzyme catalysis, Hinshelwood mechanism of catalysis	
Unit-III	**Photochemistry I**
Quantum yield, actinometry-physical and chemical actinometers, experimental techniques for continuous photolysis. Electronic transition in organic molecules, photochemistry of carbonyl compounds – Norrish Type I and Norrish Type II cleavages, photoreduction, H-atom abstraction, photocycloaddition to ketones to ethylenes, Paterno-Büchi reaction, photochemistry of unsaturated ketones, esters, acids, benzoquinones, nitrite,	
Unit-IV	**Photochemistry II**
photofries rearrangement, Barton reaction. Primary photophysical processes of atoms and diatomic molecules, spectroscopic notations, Franck-Condon principle and its applications, rates of absorption and emission, lifetimes of electronically excited states and its fate, quenching of excited states species, radiationless transition and predissociation, energy transfer processes,	
Unit-V	**Protein structure prediction and virtual library**
Photochemistry II: Wigner's spin rule, Woodward Hoffman's rule, mechanistic analysis of photochemical reactions by spectroscopic techniques, sources of high energy radiation, chemical dosimetry, comparison between photo- and radiation chemistry.	
Reference books	1. Laidler K.J., (2005) "Reaction Kinetics", Anand Sons, New Delhi. 2. Amis E.S., (2004) "Solvent Effect of Reaction Rates and Mechanism", Academic Press. 3. Mukherjee K.K., (1991) "Fundamentals of Photochemistry", New Age International Pvt. Ltd., New Delhi. 4. Turro N.J., (2003) "Modern Molecular Photochemistry", Benjamin Cumming Publications Co. 5. Lakowicz J.R., (1998) "Principles of Fluorescence Spectroscopy", Plenum Press, New York. Wishart J.F. and Nocera D.G., "Photochemistry and Radiation Chemistry", Oxford University Press, USA.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	

Approved by academic council on:	

SC 706	**Adv. Organic Chemistry-II**
Version	I
Prerequisite	All students are expected to have a general knowledge of Basics of Adv. Organic Chemistry
Learning objective	To impart advanced knowledge on reaction mechanism and pericyclic reactions.
Expected Outcome	Developed conceptual schematics required Adv. Organic Chemistry for and an ability to translate pertinent criteria into system requirements
Unit-I	**Conformation and Chemical Reactivity I**
Internal forces and strains, Conformational analysis of acyclic molecules (alkanes, halogeno alkanes and other substituted derivatives), conformational energy, diagrams, dynamic stereochemistry, reactivity of conformationally rigid and mobile diastereomers, quantitative correlation between conformation and reactivity, conformational analysis of cyclic system - mono, di and polysubstituted cyclohexanes , regiospecific, regioselective reactions, base-induced and	
Unit- II	**Conformation and Chemical Reactivity II**
pyrolytic eliminations, solvolysis, esterification, hydrolysis, oxidation, reduction, neighbouring participation reactions of acyclic and cyclic molecules. Brief idea on fused ring system- decalin , perhydroanthracene, perhydrophenanthrene and cyclopentanoperhydrophenanthrene.	
Unit-III	**Organic reaction Mechanism**
Types of Mechanism, types of Reactions, importance of product analysis, reactive intermediates and their detection, information from reaction kinetics , reaction energetics, energy profile diagrams, activation parameters, isotope effects (primary and secondary kinetic hydrogen isotope effects), LFER- Hammett, Taft equations, solvent effects, kinetic and thermodynamic controls, Hammond postulates, guide lines for proposing reaction mechanism.	
Unit-IV	**Pericyclic Reactions I**
Orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allylic system, FMO approach, Woodward-Hoffman correlation diagram method, pericyclic reactions under thermal and photochemical conditions;	
Unit-V	**Pericyclic Reactions II:**
Electrocyclic reractions-conrotatory and disrotatory motions, [4n], [4n+2]allyl systems, cyclo addition-[4n], [4n+2] systems with emphasis on [2+2] and [4+2] cyclo additions,stereochemical and substituent effects, sigmatropic rearrangements-shifts of H and carbon moieties, detailed treatment of Claisen, Cope, Sommelet-Hauser rearrangements.	

Reference books	1. Eliel E.L., Samuel H.W. and Michael P.D., 2002 "Basic Organic Stereochemistry", John Wiley & Sons. 2. Nasipuri D., 2005 "Stereochemistry of Organic Compounds", Wiley Eastern Ltd., New Delhi. 3. Woodward R.B. and Hoffman R., T 2004 he Conservation of Orbital Symmetry, Academic Press. 4. March J., 2004 Advanced Organic Chemistry, Reactions, Mechanism and Structure, John Wiley & Sons. 5. Bruckner R., 2002 "Advanced Organic Chemistry: Reaction Mechanism", Academic Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 752 Advanced Laboratory-II		
S. No.	**Content**	**Hours**
1.	**Organic Chemistry** 1. Qualitative analysis: identification of binary mixtures of organic compounds, Identification and characterization of organic compounds through m.p., derivatization, IR etc. 2. Extraction, Isolation and purification of natural products: Application of soxhlet, column chrom. and TLC, UV-vis, IR and NMR, (i) Pigments from spinach leaves (ii) Piperine from black pepper (III) Caffeine from tea leaves.	4/week
2.	**Inorganic Chemistry** Synthesis of potassium tris(oxalate) aluminate, potassium tris(oxalate) chromate and potassium tris(oxalate) ferrate, and their characterization by metal determination, various spectroscopic (I.R. and U.V.-Vis) methods, Magnetic behavior, and photochemical behavior of iron complex. Preparation of $[Ni(NH_3)_6]Cl_2/So_4$, $[Ni(en)_3]Cl_2/SO_4$, bis(salicylaldimine)-nickel(II), and analysis by different methods, viz. IR, UV-visible spectroscopy. Comparison of the spectra of $[Ni(H_2O)_6]^{2+}$, $[Ni(NH_3)_6)^{2+}$ and , $[Ni(en)_3]^{2+}$ and qualitative verification of the spectrochemical series, quantitative estimation of nickel by spectrophotometry.	4/week
3.	**Physical Chemistry** Analysis of a mixture of a metal cation by electroanalytical methods. Determination of cations in Soil /fertilizer by flame photometry. Determination of cations in lubricating oils/alloys using AAS. To calculate the surface energy of given organic liquid from surface tension versus temperature relationship.	4/week

SC 708	Electroanalytical Chemistry
Version	I
Prerequisite	All students are expected to have a basic knowledge of Basics of Electroanalytical Chemistry
Learning objective	To introduce theoretical and practical knowledge of various electroanalytical systems
Expected Outcome	Developed conceptual schematics required for Electroanalytical Chemistry and an ability to translate pertinent criteria into system requirements
Unit-I	Basics of Polarography:
Polarography and advantages of using dropping mercury electrode. Operational amplifiers concept and design of polarographic circuit using op-amps. Ilkovic equation, theory of diffusion, kinetic ,adsorption and catalytic currents. .	
Unit- II	Polarography-I
Controlled potential electrolysis and coulometry. Determination of number of electrons. Reversible, quasi-reversible and Irreversible electrode processes. Pulse and Differential pulse polarography and their superiority over DC polarography. A.C.Polarography	
Unit-III	Voltammetric Techniques:
Linear and cyclic sweep voltammetry, Randles Sevcik equation, effect of sweep rate and evaluation of adsorption characteristics of reactant or product using CV. Coupled chemical reactions and their characterization. Characteristics of commonly used working electrodes such as glassy carbon, platinum, pyrolytic graphite and reference electrodes SCE and Ag/AgCl. Enzyme catalysed oxidations of biomoleules viz., uric acid, guanine, adenine etc and their comparison with electrochemical reactions. Anodic and cathodic stripping and determination of metal ions, pollutants and biomolecules using stripping voltammetry	
Unit-IV	Sensors
Amperometric and voltammetric sensors. Modified electrodes and their advantages over conventional electrodes in sensing variety of metals and biomolecules. Nanomaterials in electrode modification- C60, single wall and multi wall carbon nanotubes. Preparation and characterization of modified surfaces, Applications of sensors in doping.	
Unit-V	Polarography and cyclic voltametry of coordination compounds
Polarographic and cyclic voltametric studies of coordination compounds containing one or more redox centers, coupled chemical reactions ❑ EE and EEE mechanisms; Stability constant of complexes.	
Reference Books	1. Meites L., Polarographic Techniques, Interscience publishers, N.Y. Third Edition. 2. Lund and Baizer, Organic electrochemistry, Marcel Dekker, N.Y. 3. Bard A.J. and Faulkner L.R., Electrochemical Methods-Fundamentals and Applications, John Wiley. 4. Sane R.T. and Joshi A.P., Electroanalytical Chemistry: Theory and Applications, Quest Publications.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 710	**Enantiomeric Separation**
Version	I
Prerequisite	All students are expected to have a general knowledge of Knowledge of stereochemistry of organic compounds .
Learning Objective	The objectives of this course are to educate students about To provide knowledge of modern chromatographic separation methods .
Expected Outcome	The student will be able to conceptualize about Developed conceptual schematics required for Enantiomeric Separation and an ability to translate pertinent criteria into system requirements
Unit-I	**Introduction:**
Modern stereochemical concepts: Chirality and molecular structure, definitions and nomenclature.	
Unit II nomenclature.	**Techniques used for studies of optically active compounds**
Methods not involving separation: polarimetry, NMR, isotope dilution, calorimetry, enzyme techniques. Determination of absolute configuration: X-ray, ORD, CD and chromatography based on comparison.	
Unit-III	**Modern chromatographic separation methods:**
Basic chromatographic theory, instrumentation – gas and liquid chromatography. **Direct optical resolution:** Theory, general aspects of chiral recognition models: coordination to transition metals, charge transfer interaction, inclusion phenomena. Thermodynamic and kinetic considerations. **Chiral gas chromatography:** Phases based on chiral metal complexes, inclusion effects-relative merits;	
Unit-IV	**Chiral liquid Chromatography:**
CSPs based on naturally occurring and synthetic polymers; Bonded synthetic chiral selectors; CMPAs	
Unit-V	**Analytical applications:**
Amino acids, natural products, pharmaceuticals, microbial and enzymatic reactions,	
Reference books	1. Kowalska,T. and Sherma, J., 2006 "Preparative Layer Chromatography", CRC-Taylor & Francis, New York. 2. Ahuja, S., 2003 "Chromatography and Separation Science", Academic Press, Amsterdam 3. Snyder, L.R., Glajch, J.L., and Kirkland, J.J., 1998 "Practical HPLC Method Development", Wiley, New York
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 711	**Heterocyclic Chemistry**
Version	I
Prerequisite	All students are expected to have a general knowledge of Basic organic chemistry and synthetic methods ..
Learning objective	To give the students a broad understanding of the major classes of 5- and 6-membered ring heterocyclic compounds.
Expected Outcome	Developed conceptual schematics required for Heterocyclic Chemistry and an ability to translate pertinent criteria into system requirements
Unit-I	**Heterocycles**
Systematic nomenclature of heterocyclic compounds (Hantzsch-Widman, Replacement & Fusion methods), Biological importance of heterocyclic compounds.	
Unit- II	**Five-membered heterocycles with one heteroatom.**
Chemical structures of furan, pyrrole and thiophene, and degree of aromaticity. General syntheses methods for 5-member rings. Paal-Knorr, Feist-Benary, Hantzsch and Knorr syntheses. Electrophilic substitution in this kind of rings, reactants employed and orientation of the substituent on the ring.	
Unit-III	**Benzoderivatives of five-membered heterocycles with one heteroatom.**
Preparation of indole and carbazole derivatives. Fisher, Bischler, Madelung and Reissert syntheses. Preparation and reactivity of benzofurans (coumarins), benzothiophenes, dibenzofurans and dibenzothiophenes.	
Unit-IV	**Pyridines, quinolines and isoquinoles**
Influence of the imine group on the reactivity of the pyridine ring. Nucleophilic and electrophilic substitutions on pyridine, quinolines and isoquinolines. Comparison of reactivity with benzene and naphthalene. Preparation of pyridine salts and pyridine *N*-oxides and synthetic applications. Skraup, Friedlander, Pfintzinger Bischler-Napieralski and Picte syntheses..	
Unit-V	**Heterocycles with 5 or 6 members and two or three heteroatoms**
Syntheses and reactivity of Oxazoles, thiazoles, oxadiazoles, thiadiazoles, benzothiazoles, benzothiadiazoles, triazole, benzotriazole, pyrimidines, pyrazines, quinoxalines, triazines, etc.	
Reference books	1. Heterocyclic chemistry, 2007 3rd Edition, T. L. Gilchrist, Pearson Education India, (ISBN: 978-0582278431) 2. Heterocyclic chemistry, M. Sainsbury, 2002 Wiley, (ISBN: 978-0-471-28164-1) 3. Handbook of heterocyclic chemistry, 2010 3rd Edition, A. R. Katritzky, C. A. Ramsden, J. A. Joule and V. V. Zhdankin, Elsevier, 4. R. R. Gupta, M. Kumar and V. Gupta, Springer, 1998. Heterocyclic chemistry, volume I: Principles, three- and four-membered heterocycles, 5. Heterocyclic Chemistry, 2010 J. A. Joule and K. Mills, Wiley-Blackwell,
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 713	**Molecular Spectroscopy**
Version	I
Prerequisite	All students are expected to have Elementary knowledge of molecular spectroscopy ..
Learning objective	To provide basic knowledge of various spectroscopic techniques required for the identification and elucidation of the structure of molecules.
Expected Outcome	Developed conceptual schematics required for Heterocyclic Chemistry and an ability to translate pertinent criteria into system requirements
Unit-I	**Introduction to spectroscopy**
Different aspects of molecular spectroscopy, the Born- Oppenheimer approximation, transition probability, oscillator strength, the integrated absorption coefficient. **Microwave Spectroscopy**: Classification of rotors, intensity of rotational lines, population of energy levels, non-rigid rotation, anharmonocity and centrifugal distortion, effect of isotopic substitution. Rotation spectra of linear, spherical top and asymmetric top polyatomic molecules, microwave technique.	
Unit- II	**Infrared Spectroscopy**
Vibrating rotor, vibration of polyatomic molecules, harmonic and anharmonic oscillators, types of vibration bands – overtones, combination bands, Fermi resonance phenomenon, the finger print region, FTIR spectroscopy and applications. **Raman Spectroscopy*:*** Rayleigh and Raman scattering, polarisabilities, rotational and vibrational Raman spectra, selection rules, polarization of the light and Raman effect, Laser Raman spectroscopy.syntheses. Electrophilic substitution in this kind of rings, reactants employed and orientation of the substituent on the ring.	
Unit-III	**UV Visible spectroscopy**:
Electronic spectra, Franck-Condon Principle, predissociation spectra, Fortrat diagram. Electronic spectra of organic compounds, types of transitions, solvent effects, empir $_{max}$, conjugated polyene and enone systems, transition in inorganic complexes, charger transfer spectra in organic and inorganic systems.	
Unit-IV	**Resonance Spectroscopy**
Magnetic Nuclear moments, nuclear spin states in a magnetic field and the resonance phenomenon, relaxation processes, Bloch equations outline of NMR detection methods; chemical shifts and spin-spin coupling, spectra of a two-spin system (A_2, AB and AX cases); interpretation of simple first order spectra of organic molecules. NMR lineshapes and molecular dynamics. FT-NMR spectroscopy, measurement of relaxation times, introduction to ^{13}C NMR spectroscopy.	
Unit-V	**Electron Spin Resonance**
detection of ESR spectra, spectra of simple organic radicals, g-values and hyperfine structure, the McConnell relation; spectra of inorganic complexes, zero field splitting and Krammers degeneracy. General introduction to double resonance experiments, Overhauser effect, DNDOR and ELDOR, 2-dimensional NMR, Zeugmatography and biological applications. of solids, application to organic molecules and surface structure studies.	
Reference books	1. Banwell C.N. and McCash E.L.M., 1999 "Fundamentals of Molecular Spectroscopy", 4th Ed.,McGraw Hill, N.Y. 2. Graybeal J.D., 1988 "Molecular Spectroscopy", McGraw-Hill. 3. Atkins P. and Paula J.de, 2003 "Physical Chemistry", 7th Ed., Oxford Univ. Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council	

on:	

SC 715 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Advanced Analytical Chemistry I**
Version	I
Prerequisite	All students are expected to have a general Knowledge of analytical Chemistry.
Learning objective	To impart knowledge of advanced topics in analytical techniques
Expected Outcome	Developed conceptual schematics required for Advanced Analytical Chemistry and an ability to translate pertinent criteria into system requirements
Unit-I	**Electroanalytical methods:**
Principle, instrumentation and applications of pulse, rapid scan, square wave and AC polarography cyclic voltammetry, coulometry at controlled potential, chronopotentiometry and anodic stripping voltammetry.	
Unit- II	**Ion sensors:**
semipermeable membranes, selectivity, different types of solid and liquid membrane sensors.	
Unit-III	**Spectral methods:**
Principle, instrumentation and applications of atomic absortion, atomic emission and atomic fluorescence, beam modulation in AAS, spectral and chemical interferences in atomic spectroscopy, Arc/ spark, laser and plasma emission techniques, qualitative and quantitative analysis.	
Unit-IV	**X-ray methods:**
X-ray spectra, x-ray absorption, emission, fluorescence and diffraction methods, monochromatization, detection of x-rays, application of x-ray spectroscopy for analyses and characterization of materials, Particle Induced X-ray Emission, Optical and electron microscopy..	
Unit V	**Mass spectrometry:**
Introduction, different types of ion sources, mass analysers and detectors, resolution and resolving power, interpretation of mass spectra, hyphenated systems – LC-MS, GC-MS, ICP-MS, MS-MS.	

Reference books	1. Mendham J., Denney R.C., Barnes J.D. and Thomas M.J.K., 2004 "Vogel's Text Book of Quantitative Chemical Analysis", 6th Ed., Pearson Education. 2. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., 2004 "Fundamentals of Analytical Chemistry", 8th Ed., Thomson Brooks/Cole. 3. Fifield F.W. and Kealey D., 2000 "Principles and Practice of Analytical Chemistry", 5th Ed., Blackwell Science. 4. Ewing G.W., 2004 "Instrumental Methods of Chemical Analysis", 5th Ed., McGraw Hill Book Company, Inc. 5. Rochow T.G. and Tuckor P.A. 2005 "Introduction to microscopy by means of light, electron, X- rays or Acoustics", Springer, 2nd Ed. 6. Jenkins R., 1999 "X-ray fluorescence spectrometry (Chemical Analysis; A series of Monographs on Analytical Chemistry and its application", Wiley-Interscience, 2nd Ed.)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 761	**Chemistry Laboratory-III**	
S.No	**Content**	**Hours**
1.	**Organic Chemistry** Multistep Synthesis, e.g.: (i) Benzophenone-benzophenone oxime - benzanilide (ii) Benzoin, benzyl, benzilic acid (iii) Diphenic acid (iv) anthranilic acid, (v) Dinitrobenzene from benzene	4/week
2.	**Inorganic chemistry:** Synthesis and spectrophotometric study of copper complexes: (i) Synthesis of bis(salicylaldimine) copper(II) and cis-bis(glycinato) copper(II), (ii) record the spectra of Cu^{2+} (bis(salicylaldimine) copper(II) and cis-bis(glycinato) in water,, NH_3 , ethylene diamine and glycine, and arrange the ligands in order of increasing field strength and (iii) quantitative estimation of copper by spectrophotometer. Study of the complex formation between Fe(III) and thiocyanate/salicylic acid/ sulphosalcylic acid or between Ni(II) and o-phenonthroline, and find the formula and determination of formation constant of the complex spectrophotometrically (Job's method and molar ratio method).	4/week
3.	**Physical chemistry:** To determine the variation of miscibility of phenol in water with temperature and to find the critical solution temperature. To determine ΔG, ΔH, and ΔS for the reaction, Zn (Hg)+2;AgCl(S)= ZnCl2(aq)+2Ag(s) from e.m.f measurements. To determine the ionization constant of bromophenol blue indicator by Spectroscopy. study the fluorescence quenching.	4/week

Elective Papers

MCY 607 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Advanced Analytical Chemistry II**
Version	I
Prerequisite	All students are expected to have a general Knowledge of analytical Chemistry.
Learning objective	To impart knowledge of advanced topics in analytical techniques
Expected Outcome	Developed conceptual schematics required for liquid liquid extraction, and chromatographic techniques and an ability to translate pertinent criteria into system requirements
Unit-I	**Radiometric methods of analysis:**
Activation methods of analysis – neutron sources, thermal and fast neutron activation, prompt gamma, charged particle and photon activation, theoretical and experimental considerations, sources of error, advantages, limitations and applications. Isotope dilution and substoichiometric analysis - advantages, limitations, and applications, instrumentation and advantages, radioimmunoassay and radio reagent methods, Positron emission spectroscopy. **Analytical Methods using particle accelerator**: Rutherford Backscattering Spectrometry and its applications to material characterization, Nuclear Microprobe and applications, Introduction to Accelerator Mass Spectrometry – a modern dating method.	
Unit- II	**Liquid-liquid extraction:**
Principle, significance of various terms, batch and counter current extraction, classification of extractants, extraction equilibria of metal chelate, ion association complexes, extraction by high molecular weight amines, synergism, stripping, backwashing, salting out agents, masking agents, emulsion formation, identification of extracting species.	
Unit-III	**Chromatographic techniques**
Plate concept, processes leading to non-ideal chromatography, van Deemter equation, plate height equation, Kovats index, high pressure liquid chromatography, bonded phase, instrumentation, detector characteristics, ion chromatography, revere phase chromatography, size exclusion chromatography, affinity chromatography.	
Unit-IV	**Ion exchange:**
Introduction, kinetic and thermodynamic considerations in ion-exchange, synthetic inorganic ion-exchangers – classification and applications, ion exchange in mixed aqueous organic media, chelating resins.	

Unit V	**Automation in microanalysis:**
Automation in analytical chemistry – automatic and automated devices instrumental parameters, principles and techniques of automatic analysers employed for microanalysis with emphasis on the basic sequences in operational modes in segmented and continuous flow, non-destructive autoanalysers in quality control. Elemental analysers, application in environmental and clinical Laboratory	
Reference books	1. Mendham J., Denney R.C., Barnes J.D. and Thomas M.J.K., 2004 "Vogel's Text Book of Quantitative Chemical Analysis", 6th Ed., Pearson Education. 2. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., 2004 "Fundamentals of Analytical Chemistry", 8th Ed., Thomson Brooks/Cole. 3. Christian G.D., 2004 "Analytical Chemistry", 6th Ed., John Wiley & Sons Inc. 4. Fifield F.W. and Kealey D., 2000 "Principles and Practice of Analytical Chemistry", 5th Ed., Blackwell Science. 5. Ewing G.W., 2004 "Instrumental Methods of Chemical Analysis", 5th Ed., McGraw Hill Book Company, Inc. 6. Ehmann W.D. and Vance D.E., 2007 "Radiochemistry and Nuclear methods of Analysis", Wiley- InterScience, new Ed.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 609 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Inorganic Biochemistry and Reaction Mechanism**
Version	I
Prerequisite	All students are expected to have a general Inorganic Biochemistry and Reaction Mechanism .
Learning objective	To familiarize the students with mechanisms of inorganic reactions and inorganic biochemistry.
Expected Outcome	Developed conceptual schematics required for Inorganic Biochemistry and Reaction Mechanism and an ability to translate pertinent criteria into system requirement
Unit-I	**Inorganic Reaction Mechanism:**
Substitution reactions in octahedral complexes*:* exchange reactions, acid- and base-hydrolysis, annation reaction, solvolytic and catalysed reactions. Substitution reactions in square-planar complexes*:* effect of non- participation of ligands on reactivity, *cis* and *trans* effects.	

Unit- II	Electron transfer reactions:
Outer- and inner-sphere mechanisms, factors affecting electron transfer reaction rates, theories of electron transfer reactions, solvated electron.	
Unit-III	**Photochemistry of metal complexes:**
Introduction to inorganic photochemistry, photochemically excited states and excited state processes for transition metal complexes, photochemical reactions of coordination compounds (Cr and Ru complexes), types of photochemical reactions in transition metal complexes: substitution, decomposition, fragmentation, rearrangement and redox reactions. Applications of photochemical inorganic reactions in synthesis, catalysis, biological processes and in lasers.	
Unit-IV	**Inorganic biochemistry:**
Metalloproteins and enzymes*:* Role of metal ions in the active sites, structure and functions of metalloproteins and enzymes containing Mg, Ca, V, Mn, Fe, Co, Ni, Cu and Zn ions. oxidases, cytochrome P-450s; Ni-urease, hydrogenase; nitrogen fixation; Cu-blue, copper protein, tyrosinase, galactose oxidase, superoxide dismutases; Zn- carbonicanhydrase, carboxypeptidase, alcohol dehydrogenase	
Unit V	**Chemical Toxicity and metallotherapy:**
Toxic chemicals in the environment; toxic effects of arsenic, cadmium, lead, mercury, carbon monoxide, cyanide and other carcinogens; metal containing drugs in therapy; interaction of heavy metal ions with DNA; DNA cleavage; structure-activity relationship and mode of action. Laboratory	
Reference books	1. Huheey J.E., Keiter E. and Keiter R., 2001 "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia, 3rd Indian reprint. 2. Wilkins R.G., 1991 "Kinetics and Reaction Mechanism of Transition Metal Complexes", 2nd Revised Ed., VCH, New York. 3. Mukherjee G.N. and Das A., 1993 "Elements of Bioinorganic Chemistry", Ist Ed., U.N. Dhur & Sons Pvt. Ltd., Calcutta. 4. Gillman G., 1996 "Pharmacological, Basis of Therapeutic", 9th Ed., McGraw Hill. 5. Bertini I., Gray H.B., Lippard S.J., Valentine J.S., 1994 "Bioinorganic Chemistry", University Science Books, U.S.A. 6. Lippard S.J., Berg J., 1994 "Principles of Bioinorganic Chemistry", University Science Books, U.S.A. Geoffrey G.L., Wrighton M.S., "Organometallic Photochemistry", Academic 1979 Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 611 **MICROBIAL DIVERSITY AND**	**Solid-State Chemistry and its Applications**

PHYSIOLOGY	
Version	I
Prerequisite	All students are expected to have a general Basics of Solid-State Chemistry and its Applications .
Learning objective	To familiarize the students with crystal structures of common inorganic compounds and characterization methods for metal complexes.
Expected Outcome	Developed conceptual schematics required for Solid-State Chemistry and its Applications and an ability to translate pertinent criteria into system requirement
Unit-I	**Crystal structure of inorganic compounds**
Crystalline solids, overview of close packing, packing efficiency, cubic, octahedral and tetrahedral interstitial sites, limiting radius ratios, method of determination of ionic radii. **Ionic crystals containing two different elements:** Cesium chloride, rock- salt, zinc blende, wurtzite, fluorite, antifluorite, nickel-arsenide, CaC_2, CdI_2 and rutile structures. **Ionic crystals containing 3 different elements:** Ilmenite, spinels, inverse spinels, garnets perovskite and K_2NiF_4. **Non-ionic crystals:** Giant molecules, layer structure, crystals composed of discrete molecules.	
Unit- II	**Defect structures**
Schottky and Frenkel defects, solid electrolytes, nonstoichiometric compounds, F-centers and other defects in nonstoichiometric compounds. **Methods to synthesize solid-state materials:** Hydrothermal, sol-gel, co-precipitation (precursor), ceramic method. Different methods to grow single crystals.	
Unit-III	**Amorphous inorganic materials:**
Glasses, refractories, materials obtained from organometallic chemical vapour deposition (OCVD). New materials: Conducting polymers, carbon nanotubes, carbon nanorods and fullerenes. Electronic materials: Insulating, semiconducting, superconducting materials, ferroelectrics, dielectrics.	
Unit-IV	**Mesoporous materials and their catalytic applications:**
various types of mesoporous materials (oxides, sulphides, etc), tailoring of pore size, applications of mesoporous materials in heterogeneous catalysis.	
Unit V	**Structural characterization of metal complexes by physical methods**
Extended X-ray absorption spectroscopic (EXAFS), X-ray photoelectron spectroscopic (XPS), X-ray absorption near edge spectroscopic (XANES), electron spin spectrometric (ESR), electron spectroscopy for chemical analysis (ESCA) studies, soild state NMR, HMBC, HMQC, Mössbauer spectroscopic studies of metal complexes, thermal methods (TG, DTA and DSC).	
Reference books	1. Douglas B.E., McDaniel D.H. and Alexander J.J., 2001 "Concepts and Models of Inorganic Chemistry", 3rd Ed., John Wiley & Sons, Inc., New York. 2. Cotton F.A., Wilkinson G., Murillo C.A. and Bochmann M.,1999 "Advanced Inorganic Chemistry", 6th Edition, John Wiley & Sons, New York. 3. Smart L. and Moore E., 2001 "Solid-state Chemistry: An Introduction", Nelson Thornes Ltd. 4. Rao C.N.R. and Gopalakrishnan J. (Ed.), 1997 "New Directions in Solid State Chemistry", Cambridge University Press, Cambridge.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 615	**Advanced Organic Chemistry II**
Version	I
Prerequisite	All students are expected to have a general Knowledge of Knowledge of spectroscopy
Learning objective	To familiarize students with the use of spectroscopy through structure determination and to design organic synthesis
Expected Outcome	Developed conceptual schematics required for Advanced Organic Chemistry and an ability to translate pertinent criteria into system requirement
Unit-I	**Structure and Synthesis of Outstanding Organic Molecules I**
Penicillins, newer penicillins, tetracycline, camphor, abietic acid, gibberellic acid,	
Unit- II	**Structure and Synthesis of Outstanding Organic Molecules** II;
morphine, quinine, cortisone, prostaglandins, quercetin, vitamins.	
Unit-III	**Determination of structures of complex organic molecules by spectroscopic means: IH-NMR**
Introduction, Coupling – vicinal and geminal coupling, long-range coupling, spin decoupling, spin systems - AX_2, A_2B_2 & A_2X_2 and AMX, ABX, & ABC types. Homotopic, enantiotopic and diastereotopic systems, chemical shift reagents, chiral resolving agents,	
Unit-IV	**NMR techniques**-I
NOE difference spectra, ^{19}F, ^{31}P NMR. 2D NMR – Introduction, NOESY, COSY, HETCOR, Carbon-13 NMR spectroscopy.	
Unit V	**Detailed study of mass spectroscopy**
Principle of mass spectroscopy, Instrumentation, Fragmentation of molecules, determination of molecular mass , characterization of organic molecules.	

Reference Books	1. Morrison R.T. and Boyd R.N., 2001 "Organic Chemistry", 6th Ed., Prentice Hall of India. 2. Solomons T.W.G. and Fryhle C.B., 2004 "Organic Chemistry", 8th Ed., Wiley Inc. 3. Finar I.L., 1997 "Organic Chemistry", Vols. 1 & 2, 6th Ed., ELBS Longman Ltd. 4. Singh J. and Yadav L.D.S., 2006 "Organic Synthesis", Pragati Prakashan. 5. Silverstein R.M. and Webster F.X., 2002 "Spectroscopic Identification of Organic Compounds", 6th Ed., Wiley Inc. 6. Pavia D.L., Lampman G.M. and Kriz G.S., 2001 Introduction to Spectroscopy, 3rd Ed., Harcourt Inc.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 617	**Advanced Physical Chemistry – I**
Version	I
Prerequisite	All students are expected to have a general **Knowledge of physical chemistry**
Learning objective	To familiarize the students with advanced concepts of physical chemistry
Expected Outcome	Developed conceptual schematics required for advanced physical Chemistry and an ability to translate pertinent criteria into system requirement
Unit-I	**Surfactants and Interfacial Phenomena:**
Classification, micellization, c.m.c. and its determination shape and structure of micelles, effect of additives on micellization, thermodynamics of micellization, solubilization and its applications, macro and micro emulsions, dispersion and aggregation of solids by surfactants.	
Unit- II	**Membranes:**
Artificial and natural membranes, Donnan membrane equilibrium, transport of electrolytes, membrane potential and ion selective electrodes.	
Unit-III	**Adsorption:**

Model for multilayer adsorption, BET isotherm, adsorption by porous, non-porous and microporous solids, estimation of specific surface and pore size distribution, special problems encountered with very narrow pores, adsorption from liquid phase.	
Unit IV	**Colloids :**
Electrical double layer and its structure, electro-kinetic potential, Verwey- Overbeek treatment of rapid and slow coagulation, properties and structure of gels, rheology, clay colloids.	
Unit V	**Macromolecules:**
Concepts of mass and number average molecular weights, methods of determining molecular weights (osmometry, viscometry, diffusion and light scattering method), sedimentation, frictional properties of macromolecules, statistical distribution of end to end dimension, calculation of average dimension of various chain structures.rheology, clay colloids.	
Reference Books	1. Rosen M.J., "Surface and Interfacial phenomena", John Wiley & Sons, N.Y. 2. Gregg, S.J. and Sing, K.S.W., "Adsorption, Surface Area and Porosity", 2nd Ed., Academic Press. 3. Adamson, A.W., "Physical Chemistry of Surfaces", 5th Ed., John Wiley & Sons, N.Y. 4. Billmeyer, F.W., "Text book of Polymer Sciences", 3rd Ed., Wiley, N.Y.
	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 619	**Advanced Physical Chemistry – I I**
Version	I
Prerequisite	All students are expected to have a general Knowledge of physical chemistry
Learning objective	To familiarize the students with advanced kinetics, thermodynamics and quantum chemistry.
Expected Outcome	Developed conceptual schematics required for Advanced physical Chemistry-ii and an ability to translate pertinent criteria into system requirement
Unit-I	**Advanced Chemical Kinetics**

Theories of unimolecular reactions, kinectics – proton transfer and electron transfer reactions, fast reactions – rapid flow, stopped – flow and relaxation techniques, molecular beam method, diffusion controlled reactions, oscillatory reactions, LFER and kinetic isotope effects, elucidation of mechanism from kinetic data.	
Unit- II	**Statistical Mechanics and Irreversible Thermodynamics I:**
Phase space, Liouville's theorem, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics. Affinities and fluxes, Reversible and irreversible processes, entropy production	
Unit-III	**Adsorption:**
Statistical Mechanics and Irreversible Thermodynamics II: some important irreversible processes, entropy flow due to exchange of mater and energy, entropy changes due to chemical reaction, affinity and coupling of chemical reaction, the phenomenological laws and equations and their applications in chemistry, fluctuations, response functions, time correlation function, distribution Function	
Unit IV	**Quantum Chemistry I**
Dirac Bra-ket notation, Addition of angular momentum, Use of ladder operators: Rigid rotor and Harmonic oscillator, Variation method: Treatment of He atom,	
Unit V	**Quantum Chemistry II:**
He atom, Perturbation method: Examples of anharmonic oscillator, He atom, Stark and Zeeman splitting, Hartree-Fock method, Introduction to post Hartree-Fock methods	
Reference Books	1. Rosen M.J., "Surface and Interfacial phenomena", John Wiley & Sons, N.Y. 2. Gregg, S.J. and Sing, K.S.W., "Adsorption, Surface Area and Porosity", 2nd Ed., Academic Press. 3. Adamson, A.W., "Physical Chemistry of Surfaces", 5th Ed., John Wiley & Sons, N.Y. 4. Billmeyer, F.W., "Text book of Polymer Sciences", 3rd Ed., Wiley, N.Y.
	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 613 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Advanced Organic Chemistry- I**
Version	III
Prerequisite	All students are expected to have a general Knowledge of organic chemistry .
Learning objective	To bring student's knowledge the concepts of pharmaceutical and biosynthesis of natural products.
Expected Outcome	Developed conceptual schematics required for Advanced Organic Chemistry and an ability to translate pertinent criteria into system requirement
Unit-I	**Pharmaceuticals**

Introduction to the clinically used drugs such as sulphonamides, antimalarials, arsenical drus, antibiotics, the penicillins, cephalosporin C, streptomycin, chloramphenicol, macrolide group of antibiotics, polypeptide antibiotics. General pharmacology, qualitative aspects of drug action, receptors, quantitative aspects of drug-receptor interactions, therapeutic index, various modes of administration of drugs, gram positive and negative micro-organisms, NSAID's and their mode of action. Representative antibacterial drugs , anticancer, anti HIV drugs, their structure mode of action.	
Unit-II	**Enzymes, coenzymes, fermentation:**
Enzymes- classification, mode of action, key features of active site, Michaelis- Menten model for kinetic properties of enzymes, enzymic inhibition-competitive and non-competitive. Enzymic oxidation of simple biomolecules. Coenzymes- catalytic role of TPP, COASH, coenzyme-I, coenzyme-II, AMP,ADP,ATP,FMN, FAD and other high energy molecules, their biogenetics, coupled reactions.	
Unit-III	**Biogenetic pathways and Biosynthesis of Natural Products**
Acetate pathway- biosynthesis of fatty acids, coenzyme-A and its role, prostaglandins and physiological activities, poly ketides, biosynthesis of aromatic compounds, Tetracyclines Mevalonate pathway-biosynthesis of isoprenoids,mono and sesquiterpenes, bicyclic diterpenes, kaurene, gibberellic acid, squalene, biosynthesis of steroids, lanosterol, zymosterol, cholesterol, calciferol, stigmasterol and their biological activities. Phytoene-biosynthesis α, β, γ carotenes and other carotenoids, 11-cis-Retinal and its biological role Shikimic acid pathway- Biosynthesis of aliphatic and aromatic amino acids, coumarins,lignans, flavones, isoflavones, flavanones,anthocyanidins	
Unit-IV	Biosynthesis of alkaloids
Biosynthesis of alkaloids- alkaloids of the pyrrolidine and piperidine series ,nicotine, anabasine, tropine, atropine, cocaine ,sedamine , coniine, amphetamine, mescaline, ephedrine, dopamine, thebaine, codeine, morphine,serotonin, melatonoin and other physiologically active alkaloids	
Unit V	**Nucleic acids:**
Human Genome project , Structure and synthesis of nucleosides and nucleotides, DNA sequencing, DNA, replication of DNA, mutation, genetic code, role of nucleic acid in the biosynthesis of proteins, DNA finger printing , DNA modification and chemical carcinogenesis, P.C. reactions	
Reference books	1. Dewick P.M., 2002 "Medicinal Natural Products: A Biosynthetic Approach", John Wiley & Sons. 2. Mann J., 2002 "Chemical Aspects of Biosynthesis", Oxford Univ.Press. 3. Stryer L., 2002 Berg J.M. and Tymoczko J.L. "Biochemistry", W.H. Freeman & Co. NY 4. Nelson D.L. and Cox M.M., 2005 "Lehninger Principles of Biochemistry" W.H. Freeman & Company. NY.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MCY 621	**Asymmetric Synthesis**
Version	I
Prerequisite	All students are expected to have a general role of asymmetry present in compounds for synthesis
Learning objective	The course is designed to familiarize the student with the principles and applications of asymmetric synthesis
Expected Outcome	The students will learn the following things; ● Importance of chirality in Asymmetric Synthesis ● Specific reaction important in chemical industries ● Asymmetric Oxidations ● Cyclization Reactions

Unit-I	**Introduction of Asymmetry**
Significance of chirality and stereoisomeric discrimination, asymmetry, determination of enantiomer composition, determining absolute configuration, general strategies for asymmetric synthesis, common definitions in asymmetric synthesis and stereochemistry.	
Unit- II	**Alkylation and Catalytic Alkylation of Carbonyl Compounds:**
Chirality transfer (intra-annular, extra-annular and chelation-enforced intra-annular); preparation of quaternary carbon centers and -amino acids; nucleophilic substitution of chiral acetal; chiral catalyst induced aldehyde alkylations: asymmetric nucleophilic addition; catalytic asymmetric additions of diethylzinc to ketones; asymmetric cyanohydrination and hydroxyphosphonylation.	
Unit-III	**Aldol and Related Reactions**
Substrate-controlled aldol reactions: oxazolidones, pyrrolidones, aminoalcohols and acylsultam systems as chiral auxiliaries; reagent- controlled aldol reactions: aldol condensations induced by chiral boron compounds, aldol reactions controlled by Corey's reagents, aldol condensations controlled by miscellaneous reagents; chiral catalyst-controlled aldol reactions: Mukaiyama's system, asymmetric aldol reactions catalyzed by chiral Lewis acids, catalytic asymmetric aldol reaction promoted by bimetallic catalysts (Shibasaki's system); double asymmetric aldol reactions; asymmetric allylation reactions; asymmetric allylation and alkylation of imines; Henry reaction.	
Unit IV	**Asymmetric Oxidations: Asymmetric epoxidation of allylic alcohols:**
Sharpless epoxidation; characteristics, mechanism and modifications and improvements of Sharpless epoxidation; selective opening of 2,3-epoxy alcohols: opening by external nucleophiles, intramolecular nucleophiles, metallic hydride reagents and organometallic compounds; Payne rearrangement, asymmetric desymmetrization of *meso*-epoxides; asymmetric dihydroxylation and aminohydroxylation of olefins; epoxidation of unfunctionalized olefins: catalytic enantioselective epoxidation of simple olefins by salen complexes and by porphyrin complexes; chiral ketone- catalysed asymmetric oxidation of unfunctionalised olefins; catalytic asymmetric epoxidation of aldehydes; asymmetric oxidation of enolates: substrate- and reagent- controlled reactions; asymmetric aziridination and regioselective ring opening of aziridines.	
Unit V	**Asymmetric Diels-Alder and Other Cyclization Reactions***:*
Chiral dienophiles: acrylate, unsaturated ketone, chiral, unsaturated N-acyloxazolidinones, chiral sulfinyl-subtituted compounds; chiral dienes; double asymmetric cycloaddition; chiral Lewis-acid catalysts: Narasaka's catalyst, chiral lanthanide catalyst, bissulfonamides chiral acyloxy borane catalysts, Brønsted acid-assisted chiral Lewis-acid catalysts, bis(oxazoline) catalysts; hetero Diels-Alder reactons: oxo- and aza-Diels-Alder reactions; intramolecular and retro-Diels-Alder reactions; asymmetric dipolar cycloaddition and asymmetric cyclopropanation.	
Reference books	1. Lin G.-Q., Li Y.-M. and Chan A.S.C., (2001) "Principles and Applications of Asymmetric Synthesis", Wiley. 2. Berkessel A. and Gröger H., (2005) "Asymmetric Organocatalysis" Wiley. 3. Ojima I.(Editor), (2004) "Catalytic Asymmetric Synthesis", 2nd Ed., Wiley. 4. Rizzacasa, M.A. and Perkins M., (2000) "Stoichiometric Asymmetric Synthesis", Academic Press.
	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 604	PROJECT PROPOSAL PREPARATION AND PRESENTATION
Version	I
Prerequisite	All students are expected to have a general knowledge of organic chemistry
Learning objective	The learning objective of course are: to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Expected Outcome	The student will be able to conceptualize about ● Formulate a scientific question; ● Present scientific approach to solve the problem; ● Interpret, discuss and communicate scientific results in written form; ● Gain experience in writing a scientific proposal; ● Learn how to present and explain their research findings to the audience effectively.
Unit-I	**Project proposal preparation**
Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.	
Unit- II	**Poster presentation**
Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.	
Unit-III	**Oral presentation**
At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 602	DISSERTATION
Version	I
Prerequisite	All students are expected to have a general knowledge of basic principles of Chemistry.
Learning objective	The learning objectives of 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.
Expected Outcome	The student will be able to conceptualize about 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: 1. In-depth knowledge of the chosen area of research. 2. Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis. 3. Competence in research design and planning. 4. Capability to create, analyse and critically evaluate different technical solutions. 5. Ability to conduct research independently. 6. Ability to perform analytical techniques/experimental methods. 7. Project management skills. 8. Report writing skills. 9. Problem solving skills. 10. Communication and interpersonal skills.
Unit-I	**Planning and performing experiments**
Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.	
Unit- II	**Thesis writing**
At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.	
Mode of Examination	student seminar/PPT
Recommended By BOS on:	
Approved by academic council on:	

SCHOOL OF APPLIED SCIENCES
M.Sc. Chemistry
DETAILED SYLLABUS

DI 602 DISSERTATION/ PROJECT WORK

CLASS-M.Sc. Chemistry IV Sem	**EVALUATION**
Schedule Per Week Practicals:	Examination Time = Three (3) Hours Max. Marks =100 [Internal Assesment (60) & Semester End Exam (40)]

The Project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation of the work done. The dissertation submitted by the candidate shall be evaluated by one External expert ,Head of the Department and supervisor of the candidate. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under.

Max. Marks:- 100

Dissertation Record	60 marks
Viva Voce	40 marks
Total	100 marks

Scheme of Examination

General Guide-lines for Course of Study

1. The whole syllabus is divided into five units.
2. Number of teaching hours required to finish the contents of each unit are mentioned in the syllabus.
3. Books recommended/references are given at the end of each paper separately.
4. In P.G. programme list of periodicals for consultation are also given.
5. Two questions will be set from each unit and student will have to attempt one question from each unit.
6. Maximum time allowed for answering each question paper is 3 hours.
7. Maximum marks allotted to a paper are 70.

Examination Pattern

Evaluation will be done under two headings:

1. Theoretical Examination &Sessionals
2. Practical Examination & Sessional

1. Theoretical Examination (100 Marks):

This will be further divided under two categories

(i) Internal Assessment	: 40 Marks	(40% Component)
(ii) End term Assessment	: 60 Marks	(60% Component)

(i) Internal Assessment (40 Marks): This is the 40% component of the total 100% theoretical examination & is further divided as follows

Process	Mid Term I	Mid Term II	Weekly Tests (1+1)	Assignment (1+1)	Total
Marks	10	10	05+05=10	05+05=10	40

Two Mid Term Examinations, Two Weekly Tests per subject and two assignments from each unit will be conducted for assessment as per the following schedule:

- After Completion of 1st Unit : Weekly test - I (to cover unit – I) and 2 assignments
- After Completion of 2nd Unit : Mid Term Exam-I and 2 assignment (to cover unit 1 & 2)
- After Completion of 3rd Unit : Weekly test – II (to cover unit 3) and 2 assignment
- After Completion of 4th Unit : Mid Term Exam – II & 2 assignments (to cover unit – 3 & 4)
- After Completion of 5th Unit : End Term Exams & 2 assignments (to covers all 5 units)

After completion of each unit, two assignments from each unit are to be given to the students, which will be submitted by the student after two working days. Thus total of 10 assignments will be assessed per semester. The Mid Term examination will be of 90 Min. duration and the concerned faculty members will be responsible for the question papers & evaluation.

Mid Term marks will be displayed within two working days of exams.

(ii) End Term Assessment (70 Marks): End term examination will be of 3.00 hrs duration and the question paper and the evaluation system will be as follows

Question Paper: For paper setting each subject, paper should be sent to three paper setters randomly and then any one paper will be selected randomly.

Evaluation System: Final result will be declared within one month after completion of examination. Centralized evaluation will be undertaken for End Term examinations.

2. Practical Examination &Sessionals (100 Marks):

The practical examination is also further divided into two categories i.e.

(i) Internal Assessment	: 60 Marks	(60% Component)
(ii) End Term Assessment	: 40 Marks	(40% Component)

(i) Internal Assessment (60 Marks): This is the 60% component of the total 100% practical examination and is further divided as follows

Process	Lab	Attendance	File work	Lab Project	Viva Voice	Total
Marks	10	10	10	20	10	60

- The internal exam component will be awarded on the basis of total number of experiments conducted during the practical classes.
- Marks of attendance will be awarded based on percentage of attendance. The students will be detained if the total percentage falls below 75% in all subjects taken together.
- The file work will depend on the submission of detailed theory & experimented record.
- Overall presentation on the practicals performed during the semester will be taken into consideration for award of marks.
- Internal viva on the practicals performed will form the basis for award of marks in Viva-Voce.

(iii) End Term Assessment (40 Marks): This examination will be final practical examination the evaluation of the final examination should be done on same day as given below:

Process	Performance of the practical	Quiz	Viva voce	Total
Marks	15	15	10	40

(iv) Mid-Term exams, weekly test and assignment will be reflected in the academic calendar.

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES

Teaching and Examination Scheme for M.Sc. (Physics) Degree (2 Year Course)
ACADEMIC SESSION 2021 - 2023

Year: I **Semester: I**

S. No.	Course Code	Course Name	Type of course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
1	PC 501	Proficiency in Co-Curricular Activity	University Core	2					100	
2	SC 521	Classical Mechanics	Program Core	4	3	1	0	3	40	60
3	SC 523	Quantum Mechanics	Program Core	4	3	1	0	3	40	60
4	SC 525	Mathematical Physics	Program Core	4	3	1	0	3	40	60
5	SC 527	Statistical Mechanics	Program Core	4	3	1	0	3	40	60
6	SC 565	Physics Lab –I	Program Core	2	0	0	6	3	60	40
7	SC 563	Seminar– I	Program Core	2	0	0	4	0	60	40
		Total		**22**	**12**	**4**	**10**			

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**
S= Seminar **P= Practical** **ESE= End Semester Examination**

Members of BoS, Applied Sciences **Convener, BoS Applied Sciences**

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES

Teaching and Examination Scheme for M.Sc. (Physics) Degree (2 Year Course)
ACADEMIC SESSION 2021 - 2023

Year: I **Semester: II**

S. No.	Course Code	Course Name	Types of course core/elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/ S	P		CIE	ESE
1	EM-502	Employability Skills I	University Core	1	1	0	0	3	60	40
2	PC-502	Proficiency in Co-Curricular Activity	University Core	2	0	0	0	0	100	
3	SC 802	Electrodynamics and Electromagnetic Theory	Program Core	4	3	1	0	3	40	60
4	SC 804	Condensed Matter Physics	Program Core	4	3	1	0	3	40	60
5	SC 806	Advanced Electronics	Program Core	4	3	1	0	3	40	60
6	SC 808	Atomic and Molecular Physics	Program Core	4	3	1	0	3	40	60
7	SC852	Computational Physics Lab	Program Core	2	0	0	6	3	60	40
8	SC854	Seminar-II	Program Core	2	0	0	4	3	60	40
		Total		**23**	**13**	**4**	**10**			

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**
S= Seminar **P= Practical** **ESE= End Semester Examination**

Members of BoS, Applied Sciences **Convener, BoS Applied Sciences**

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES

Teaching and Examination Scheme for M.Sc. (Physics) Degree (2 Year Course)
ACADEMIC SESSION 2021 - 2023

Year: II **Semester: III**

S.No.	Course Code	Course Name		Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
1	EM-601	Employability Skills II	**University Core**	1	1	0	0	3	60	40
2	PC-601	Proficiency in Co-curricular Activity	**University Core**	2	0	0	0		100	
3	SC 811	Nuclear and Particle Physics	**Program Core**	4	3	1	0	3	40	60
4	SC 813	Experimental Techniques of Physics	**Program Core**	4	3	0	1	3	40	60
5	SC 855	Physics Lab-III	**Program Core**	2	0	0	6	3	60	40
6	SC 857	Seminar – III (Dissertation Review)	**Program Core**	2	0	0	4	0	60	40
7		**Elective I**	**Program Core**	4	3	1	0	3	40	60
8		**Elective II**	**Program Core**	4	3	1	0	3	40	60
		Total		**39**	**25**	**7**	**11**			

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**
S= Seminar **P= Practical** **ESE= End Semester Examination**

Elective List:

SC 821	Microwave Electronics
SC 823	Optoelectronics
SC 825	Nanotechnology
SC 827	Electrochemical Energy Storage Systems
SC 829	Renewable Energy
SC 831	Vacuum Science and Thin Film Technology

Members of BoS, Applied Sciences **Convener, BoS Applied Sciences**

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES

Teaching and Examination Scheme for M.Sc. (Physics) Degree (2 Year Course)
ACADEMIC SESSION 2021 – 2023

Year : II **Semester: IV**

S.No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CIE	ESE
1	SC 812	Dissertation / Project work	20				2		100
2	SC 814	IPR	4	3	1	0	3	40	60
		Total	**24**	**3**					

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**
S= Seminar **P= Practical** **ESE= End Semester Examination**

Members of BoS, Applied Sciences **Convener, BoS Applied Sciences**

Credits 4 (L:T:P = 3:1:0) **Semester: I** **Program Core**

Topic and Contents	Hours	Marks
SC 521 Classical Mechanics		
UNIT-1	**7**	**12**
Newtonian mechanics of one and many particle systems, Simple pendulum with rigid support, Two connected masses with string passing over a pulley, Virtual work, Rolling mass inside and outside a circular ring, Constraints, holonomic and non-holonomic constraints, D'Alembert's Principle and Lagrange's Equation, velocity dependent potentials, simple applications of Lagrangian formulation.		
UNIT-2	**7**	**12**
Hamilton Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle. Extension of Hamilton's Principle for nonconservative and nonholonomic systems, Method of Lagrange's multipliers, Conservation theorems and Symmetry Properties, Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space.		
UNIT-3	**7**	**12**
Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivationof Hamilton's canonical Equation from Hamilton's variational principle. The principle of least action.		
UNIT-4	**8**	**12**
Canonical transformation, integral invariant of Poincare: Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's theorem, Hamilton-Jacobi equation and its application.		
UNIT-5	**7**	**12**
Action angle variable adiabatic invariance of action variable: The Kepler problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and its applications. Orthogonal transformation, Euler's theorem, Eigenvalues of the inertia tensor, Euler equations, force free motion of a rigid body.		
TOTAL	**36**	**60**

Reference Books

1. Herbert Goldstein, Charles Poole, John Safko, Classical Mechanics, Perason Education
2. A. Ray choudhary, Classical Mechanics, Oxford University Press
3. N. C. Rana and P. S. Joag Classical Mechanics, Tata McGraw Hill.
4. J.C. Upadhyaya, Classical Mechanics< Himalaya Publishing House.
5. https://nptel.ac.in/courses/115/106/115106123/
6. https://nptel.ac.in/courses/115/106/115106068/

Credits 4 (L:T:P = 3:1:0) **Semester: I** **Program Core**

Topic and Contents	Hours	Marks
SC 523 Quantum Mechanics		
UNIT-1	**7**	**12**
Formulation of Quantum Mechanics: Review of quantum postulates, Mathematical properties of linear vector spaces, postulates of quantum mechanics. Eigenvalues and eigenvectors, orthonormality, completeness, closure. Dirac's bra and ket notation. Matrix. representation of operators. Position and momentum representations- connection with wave mechanics. Commuting operators. Generalized uncertainty principle. Change of basis and unitary transformations. Expectation values, Ehrenfest theorem.		
UNIT-2	**7**	**12**
Schrodinger picture, Heisenberg picture. Heisenberg equation of motion. Classical limit. Solution of harmonic oscillator problem by the operator method. Symmetries in quantum mechanics: general views of symmetries. Spatial translation- continuous and discrete. Time translation, parity, and Time reversal. Angular Momentum: Commutation relations of angular momentum operators. Eigen values and eigen functions. Ladder operators and their matrix representations. Addition of angular momenta. Clebsch-Gordan coefficients.		
UNIT-3	**7**	**12**
Approximation methods for stationary systems: Time independent perturbation theory: non-degenerate and degenerate. Applications to Zeeman effect, isotropic shift, and Stark effect. Approximation methods for time dependent problems: Interaction picture. Time dependent perturbation theory. Transition to a continuum of final states- Fermi's Golden rule.		
UNIT-4	**8**	**12**
Scattering Theory: Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.		
UNIT-5	**7**	**12**
Klein-Gordon and Dirac equations. Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin orbit coupling. Energy levels in a Coulomb field		
TOTAL	**36**	**60**

Reference Books

1. S Flugge, Quantum Mechanics, Springer
2. D.J. Griffith, Introduction to Quantum Mechanics, Cambridge University Press.
3. Quantum Physics by H.C. Verma, TBS Publications.
4. R.Shankar, Principles of Quantum Mechanics, Springer.
5. L.I. Schiff, Quantum Mechanics, Mc-Graw Hill.
6. https://nptel.ac.in/courses/115/104/115104096/
7. https://nptel.ac.in/courses/115/101/115101107/

Credits 4 (L:T:P = 3:1:0) **Semester: I** **Program Core**

Topic and Contents	Hours	Marks
SC 525 Mathematical Physics		
UNIT-1	**7**	**12**
Coordinate transformations, scalars, contravariant and covariant vectors, definition of contra varient, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors, quotient rule. Christoffel symbols, transformation of Christoffel symbols, covariant differentiation, Ricci's theorem, divergence, Curl and Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form.		
UNIT-2	**7**	**12**
Separation of variables-ordinary differential equations, singular points, series solutions leading to Legendre, Bessel, Hermite, Laguerre functions as solutions. Orthogonal properties and recurrence relations of these functions. Spherical harmonics and associated Legendre polynomials. Hermite polynomials. Sturm-Liouville systems and orthogonal polynomials. Wronskian-linear independence and linear dependence.		
UNIT-3	**7**	**12**
Functions of complex variable, Limits and continuity, differentiation, Analytical functions, Cauchy- Riemannn conditions, Cauchy Integral theorem, Cauchy integral formula, Derivatives of analytical functions, Liouville's theorem. Power series Taylor's theorem, Laurent's theorem. Calculus of residues –poles, essential singularities and branch points, residue theorem, Jordan's lemma, singularities on contours of integration, evaluation of definite integrals.		
UNIT-4	**8**	**12**
Fourier Transforms: Development of the Fourier integral from the Fourier Series, Fourier and inverse Fourier transform: Simple Applications: Finite wave train, Wave train with Gaussian amplitude, Fourier transform of derivatives, solution of wave equation as an application. Convolution theorem. Intensity in terms of spectral density for quasi monochromic EM Waves, Momentum representation.		
UNIT-5	**7**	**12**
Application of Fourier transform to diffraction theory: diffraction pattern of one and two slits. Laplace transforms and their properties, Laplace transform of derivatives and integrals, derivatives and integral of Laplace transform. Convolution theorem. Impulsive function, Application of Laplace transform in solving linear, differential equations with constant coefficient with variable coefficient andlinear partial differential equation		
TOTAL	**36**	**60**

Reference Books

1. Mathematical Physics by P K Chattopadhyay, Wiley Eastern Lit., Mumbai
2. Introduction to Mathematical Physics by C Harper, PHI
3. Mathematical Physics by Satya Prakash, S Chand and Sons, New Delhi
4. https://nptel.ac.in/courses/115/106/115106086/
5. https://nptel.ac.in/courses/115/105/115105097/

Credits 4 (L:T:P = 3:1:0) **Semester: I** **Program Core**

Topic and Contents	Hours	Marks
SC 527 Statistical Mechanics		
UNIT-1	**7**	**12**
Elementary probability theory: Preliminary concepts, Random walk problem, Binomial distribution, mean values, standard deviation, various moments, Gaussian distribution, Poisson distribution, mean values. Probability density, probability for continuous variables.		
UNIT-2	**7**	**12**
Extensive and intensive variables, laws of thermodynamics, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) dielectric material. The laws of thermodynamics and their consequences.		
UNIT-3	**7**	**12**
Statistical description of system of particles: State of a system, microstates, ensemble, basic postulates, behavior of density of states, density of state for ideal gas in classical limit, thermal and mechanical interactions, quasi-static process. Statistical thermodynamics: Irreversibility and attainment of equilibrium, Reversible and irreversible processes. Thermal interaction between macroscopic systems, approach to thermal equilibrium, dependence of density of states on external parameters, Statistical calculation of thermodynamic variables.		
UNIT-4	**8**	**12**
Classical statistical mechanics: Microcanonical ensembles and their Equivalence, Canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition function and grand partition function, ideal gas, Gibbs paradox, validity of classical approximation, equipartition theorem. Maxwell-Boltzmann gas velocity and speed distribution. Chemical potential, Free energy and connection with thermodynamic variables, First and Second order phase transition.		
UNIT-5	**7**	**12**
Formulation of quantum statistics, Density Matrix, ensembles in quantum statistical mechanics, simple applications of density matrix. The theory of simple gases: Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac gases. Statistics of occupation numbers, Evaluation of partition functions, Ideal gases in the classical limit. Ideal Bose system: Thermodynamic behavior of an Ideal Bose gas, Bose-Einstein condensation. Thermodynamics of Black body radiation, Stefan-Boltzmann law, Wien's displacement law. Specific heat of solids (Einstein and Debye models). Ideal Fermi System: Thermodynamic behavior of an ideal Fermi gas, degenerate Fermi gas, Fermi energy and mean energy, Fermi temperature, Fermi velocity of a particle of a degenerate gas.		
TOTAL	**36**	**60**

Reference books:

1. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill.
2. R. K. Pathria, Statistical Mechanics, Pergamon Press.
3. B. B. Laud Fundamentals of Statistical Mechanics, New Age.
4. https://nptel.ac.in/courses/115/103/115103113/
5. https://nptel.ac.in/courses/115/106/115106111/

Credits 4 (L:T:P = 3:1:0) **Semester: II** **Program Core**

Topic and Contents	Hours	Marks
SC 802 Electrodynamics and Electromagnetic Theory		
UNIT-1	**7**	**12**
Electric field, Gauss Law, Differential form of Gaussian law. Surface distribution of charges and dipoles and discontinuities in the electric field and potential, Poisson and Laplace equations, Green's Theorem, Formal Solutions of electrostatic boundary value problem with Green's function, Electrostatic potential energy and energy density, capacitance.		
UNIT-2	**7**	**12**
Boundary Value Problems in Electrostatics: Methods of Images, Point charge at different conditions, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential, conducting sphere with hemispheres at a different potentials, orthogonal functions and expansion.		
UNIT-3	**7**	**12**
Multipole expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment of electrostatics with permeable media. Boundary value problems with dielectrics. Molar polarizability and electric susceptibility. Models for molecular polarizability, electrostatic energy in dielectric media.		
UNIT-4	**8**	**12**
Time varying fields, Maxwell's equations, conservation laws: Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, coulomb gauge, Green function for the wave equation, Derivation of the equations of Macroscopic Electromagnetism, Poynting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields. Conservation laws for macroscopic media.		
UNIT-5	**7**	**12**
Lorentz' transformations; Group symmetries of Lorentz' transformations, Electromagnetic field tensor, Relativistic electrodynamics using potential, Four vector formalism, Relativistic energy and momentum, transformation of four potentials and four currents, Relativistic transformations of electro-magnetic fields, Maxwell's equations in covariant form. Invariance of electric charge, covariance of electrodynamics.		
TOTAL	**36**	**60**

Reference books:

1. J.D. Jackson: Classical Electrodynamics, Wiley
2. David J. Griffiths: Introduction to Electrodynamics, Benjamin Cummings
3. L.D. Landau and E.M. Lifshitz, Classical Theory of Electrodynamics, Addison-Wesley.
4. L.D. Landau and E.M. Lifshitz, Electrodynamics of Continuous Media,Addison-Wesley.
5. https://nptel.ac.in/courses/115/106/115106122/

Credits 4 (L:T:P = 3:1:0) **Semester: II** **Program Core**

Topic and Contents	Hours	Marks
SC 804 Condensed Matter Physics		
UNIT-1	**7**	**12**
Crystal solids, unit cells, two- and three-dimensional Bravais lattices, crystal systems, crystal planes and Miller indices, close packed structures, symmetry elements in crystals, point groups and space groups, crystal structure factor and determination: X-ray, electron and neutron diffraction, Ewald construction, reciprocal lattices and its applications to diffraction techniques.		
UNIT-2	**7**	**12**
Bonding in crystal: the van der Waals bond, cohesive energy of inert gas solids, ionic bond, cohesive energy and bulk modulus of ionic crystals, Madelung constant, the covalent bond, metallic bond; defects in crystals: point defects, line defects, Burger's vector, dislocation density, surface defects, grain boundaries and stacking faults.		
UNIT-3	**7**	**12**
Thermal conductivity of solids: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; quantization of lattice vibrations, the concept of phonons and quantization; phonon momentum, inelastic scattering of neutrons by phonons, surface vibrations. Brillouin zones.		
UNIT-4	**8**	**12**
Thermal expansion, Boltzmann's transport equation, electrical and thermal conductivities of solid, Wiedemann-Franz law, Free electron theory of metals; Hall effect in metal, electrons in periodic lattice: Bloch theorem, the Kronnig- Penney model, band theory, classification of solids on the basis of band theory, effective mass of electron and hole, Fermi surface and Fermi gas, Fermi level, carrier concentration in extrinsic and intrinsic semiconductors.		
UNIT-5	**7**	**12**
Superconductivity and its historical perspective, critical temperature, type-I and type II superconductors, persistent current, effect of magnetic field, Meissner effect, thermodynamics of superconductors.		
TOTAL	**36**	**60**

Reference Books

1. M.L. Cohen, Fundamentals of Condensed Matter Physics.
2. A. Aharony, Introduction to Solid State Physics, World Scientific.
3. P. M. Chaikin, Principles of Condensed Matter Physics, Cambridge University Press.
4. Charles Kittle, Introduction to Solid State Physics, Wiley

Credits 4 (L:T:P = 3:1:0) **Semester: II** **Program Core**

Topic and Contents	Hours	Marks
SC 806 Advanced Electronics		
UNIT-1	**7**	**12**
Synthesis of two terminal reactive networks – Driving point impedance and admittance, Foster's reactance theorems, properties of poles and zeros of reactance function, canonic networks. Four-terminal two-port network – parameters for symmetrical and unsymmetrical networks; image, iterative and characteristic impedances; propagation function; lattice network; Bisection theorem and its application. Filters and Attenuators.		
UNIT-2	**7**	**12**
p-n junction physics- Fabrication steps; thermal equilibrium condition; depletion capacitance; current-voltage characteristics; charge storage and transient behavior; junction breakdown; heterojunction. Characteristics of some semiconductor devices- BJT, JFET, MOS, LED, Solar cell, Tunnel diode, Gunn diode and IMPATT.		
UNIT-3	**7**	**12**
Differential amplifier; circuit configurations; dual input, balanced output differential amplifier; DC analysis; AC analysis; inverting and non-inverting inputs; CMRR; constant current bias level transistor. Block diagram of a typical Op-Amp analysis. Open loop configuration inverting and noninverting amplifiers. Op-amp with negative feedback; voltage series feedback; effect of feedback on closed loop gain, input resistance, output resistance; bandwidth and output offset voltage; voltage follower. Practical Op-amp; input offset voltage; input bias current; input offset current; total output offset voltage; CMRR frequency response.		
UNIT-4	**8**	**12**
Combinational Logic: The transistor as a switch, OR, AND and NOT gates, NOR and NAND gates; Boolean algebra; Demorgan's theorems; Exclusive OR gate; Adder, Decoder/Demultiplexer; Data selector/multiplexer; Encoder. Sequential Logic: Flip-Flops: A 1-bit memory; The RS Flip-Flop; JK Flip-Flop; JK master slave Flip-Flop; T Flip-Flop; D Flip-Flop; Shift registers; synchronous and asynchronous counters; cascade counters..		
UNIT-5	**7**	**12**
Op-Amp Circuits: Characteristics of ideal and practical op-amp; Nonlinear amplifiers using op-amps- log amplifier, anti-log amplifier, regenerative comparators; Active filters; precision rectifiers; ADC and DAC circuits; Op-amp based self oscillator circuits- RC phase shift, Wien bridge, non-sinusoidal oscillators		
TOTAL	**36**	**60**

Reference Books

1. The art of electronics, Paul Horowitz and Winfield Hill, (Second Edition, 1992), Foundation Books, New Delhi.
2. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
3. Digital principles and applications, Donald P Leach and Albert Paul Malvino, (Fifth Edition, 2002), Tata McGraw Hill.

Credits 4 (L:T:P = 3:1:0) **Semester: II** **Program Core**

Topic and Contents	Hours	Marks
SC 808 Atomic and Molecular Physics		
UNIT-1	**7**	**12**
Atomic Structure and Atomic Spectra Rutherford's Model and concept of stability of atom, Bohr'smodel, Sommerfeld's model, Stern-Gerlach experiment for electron spin, Revision of quantum numbers, exclusion principle, electron configuration, Hund's rule etc.		
UNIT-2	**7**	**12**
Gross structure of energy spectrum of hydrogen atom. Nondegenerate first order perturbation method, relativistic correction to energy levels of an atom, atom in a weak uniform external electric field – first and second order Stark effect, calculation of the polarizability of the ground state of hydrogen atom and of an isotropic harmonic oscillator; degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels.		
UNIT-3	**7**	**12**
Orbital magnetic dipole moment, spin-orbit interaction energy, Hartree theory, LS coupling, origin of spectral lines, selection rules, some features of one-electron, two-electron spectra and X-ray spectra, fine spectra, hyperfine structure, Zeeman effect. Lamb shift (only qualitative description)		
UNIT-4	**8**	**12**
The nature of chemical bonds, valence bond approach and molecular orbital approach for molecular bonding (for H2 molecule). Bonding and antibonding orbitals, pi- bonds, sigma - bonds, different kinds of bonding mechanism, Madelung constant, hybridization, bonding in hydrocarbons.		
UNIT-5	**7**	**12**
Molecular spectra: Rotational levels in diatomic and polyatomic molecules, vibrational levels in diatomic and polyatomic molecules, diatomic vibrating rotator, Born-Oppenheimer approximation, symmetry of the molecules and vibrational levels, experimental aspects of vibrational and rotational spectroscopy of molecules, polarization of light and Raman effect, Raman Spectroscopy.		
TOTAL	**36**	**60**

Reference books:

1. Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.
2. H. E. White, Introduction to Atomic Spectra, McGraw Hill.
3. Arthur Beiser, Perspectives of Modern Physics, McGraw Hill.
4. Gerhard Herzberg Molecular Spectra and Molecular Structure, Krieger Pub Co.
5. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
6. https://nptel.ac.in/courses/115/105/115105100/

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 811 Nuclear and Particle Physics		
UNIT-1	**7**	**12**
Properties of Nucleus & Nuclear Forces: Shape and size, mass and relative abundances, spin and parity, binding energy & nuclear stability, nuclear compositions, quantum properties of nucleon states, radioactivity: laws of radioactivity, radioactive dating, radioactive series.		
UNIT-2	**7**	**12**
Theory of alpha, beta & gamma decays and their properties, nuclear forces: properties of nuclear forces, two nucleon systems deuteron with potentials, n-p and p-p/n-n interactions at different energies, exchange forces and tensor forces, Yukawa's hypothesis, meson theory of nuclear force, Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations) Reduced transition probability, Selection rules; Internal conversion and zero-zero transition		
UNIT-3	**7**	**12**
Fermi gas model, liquid drop model and Bethe-Weizsacker formula, their applications; shell model and shell structure, extreme single particle shell model with potentials – square well, harmonic oscillator; spin orbit interaction, magic numbers, predictions of the shell model; collective nuclear model; superconductivity model (qualitative idea only), Collective Nuclear Models and characteristics.		
UNIT-4	**8**	**12**
Types of nuclear reactions and conservation laws, nuclear reaction kinematics, nuclear scattering cross section determinations, compound nucleus disintegration, Breit Wigner dispersion formula (one level), direct reactions, nuclear transmutation reactions, nuclear fission and fusion, partial wave analysis of reaction cross section, compound nucleus formation and breakup, resonance scattering and reaction-Briet –Weigner dispersion formula for s-waves (l=0), continuum cross section, statistical theory of nuclear reactions		
UNIT-5	**7**	**12**
General characteristics of weak interaction; nuclear beta decay and lepton capture; electron energy spectrum and Fermi-Kurie plot; Fermi theory of beta decay (parity conserved election rules Fermi and Gamow-Teller) for allowed transitions; ft-values; General interaction hamiltonian for beta decay with non-conserving terms; Forbidden transitions; Experimental verification of parity violation.		
TOTAL	**36**	**60**

Reference books:

1. J.M. Bhatt and V.E. Weisskipf : Theoretical Nuclear Physics.
2. B.K. Agarwal : Nuclear Physics (Lokbharti Publication Allahabad. 1989).
3. R.R. Roy and B.P.Nigam : Nuclear Physics (Willey -Easter, 1979).
4. M.A. Preston & R.K. Bhaduri : Structure of the Nucleus (Addition-Wesley, 1975).
5. https://nptel.ac.in/courses/115/103/115103101/

School of Applied Sciences

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 813 Experimental Techniques in Physics		
UNIT-1	**7**	**12**
Measurement of low resistance: two probe, three probe and four probe methods, Lock-in amplifier; measurement of capacitance High frequency measurements.Basic concepts, design of vacuum chamber, pumps; measurement of pressure: Gauges.Production of low temperature, measurement of low temperature. Low temperature device construction.		
UNIT-2	**7**	**12**
Sources of Electromagnetic Radiations: Different types of radiations (X-rays, UV-VIS, IR, microwaves and nuclear) and their sources. Detectors: X-rays, UV-VIS, IR, microwaves and nuclear detectors. Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, dielectric, acoustic, thermal, optical, mechanical, pressure, IR,UV, gas and humidity with examples.		
UNIT-3	**7**	**12**
X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Laue's method, Rotating crystal method, Powder (DebyeScherrer) method, Derivation of Scherrer formula for size determination, Neutron Diffraction: Principle, Instrumentation and Working. Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors. Numericals.		
UNIT-4	**7**	**12**
Optical Microscopy: Principle, Instrumentation and Working of optical microscope Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED) Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM) Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle, Instrumentation and Working.		
UNIT-5	**8**	**12**
Spectroscopic characterization (principle, instrumentation and working): InfraRed (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray photoelectron spectroscopy (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR). Numericals.		
TOTAL	**36**	**60**

Reference Books

1. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
2. Instrumental Methods of Chemical Analysis, G.Chatwal & S.Anand, Himalaya Publishing House.
3. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers.
4. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, (1992)
5. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001).
6. https://nptel.ac.in/courses/115/105/115105110/
7. https://nptel.ac.in/courses/115/105/115105120/
8. https://nptel.ac.in/courses/115/105/115105121/

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 821 Microwave Electronics		
UNIT-1	**7**	**12**
Introduction to microwaves and its frequencies spectrum Application of microwaves. Wave Guides :(a) Rectangular wave guides: Wave equation & its solutions, TE & TM modes. Dominant mode and choice of wave guide Dimensions Methods of excitation of wave guide. (b) Circular wave guide-wave equation & it solutions, TE, TM & TEM modes. (c) Attenuation - Cause of attenuation in wave guides, wall current. & derivation of attenuation constant, Q of the wave guide.		
UNIT-2	**7**	**12**
Resonators: Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter).		
UNIT-3	**7**	**12**
Ferrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators. Microwave tubes: Space.		
UNIT-4	**8**	**12**
Magnetrons: Types & description, Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics. Traveling wave tubes: O & M type traveling wave tubes. Gyrotorons: Constructions of different Gyrotrons, Field - Particle Interaction in Gyrotron..		
UNIT-5	**7**	**12**
Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, Coupling using direction coupler. Complex permitivity of material & its measurement: definition of complex of solids, liquids and powders using shift of minima method.		
TOTAL	**36**	**60**

Reference Books

1. Electromagnetic Waves & Radiating System-Jorden & Balmain.
2. Theory and Applications of Microwaves A.B. Brownwell & R.E. Beam (Mc Graw Hill).
3. Introduction to Microwave Theory by Atwater (McGraw Hill).
4. Principles of Microwave circuits by G.C. Montogmetry (McGraw Hill).

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 823 Optoelectronics		
UNIT-1	**7**	**12**
Semiconducting materials and Heterostructures; Electronic, transport and optical properties of semiconductors: Direct and Indirect bands; Degenerate and non-degenerate semiconductors, Doping and degeneracy; Allowed, forbidden and phonon assisted optical transitions; Switching; Colour centres; Photoconductivity; Internal quantum efficiency, External quantum efficiency; Double heterojunction, Fabrication of heterojunction, Quantum wells and superlattices.		
UNIT-2	**7**	**12**
LEDs (spontaneous emission, LED structure-surface emitting, Edge emitting-Injection efficiency, recombination efficiency, LED characteristics, spectral response, modulation, Band width, Laser diodes, Basic principle, condition for gain-Laser action-population inversion-stimulated emission, Injection Laser diode, structure, temperature effects, modulation, comparison between LED and ILDs.		
UNIT-3	**7**	**12**
Optical detectors-optical detector principle, absorption coefficient, detector, characteristics, Quantum efficiency, responsivity, response time-bias voltage, Noise in detectors P-N junction-photo diode, characteristics, P-I-N-photo diode, response, Avalanche photo diode (APD) multiplication process-B,W-Noise photo transistor.		
UNIT-4	**8**	**12**
Optical Fibre, structure, advantages, Types-propagation-wave equation, phase and group velocity, transmission characteristics, attenuation-absorption, scattering losses-dispersion, fibre bend losses, source coupling, splices and connectors-wave length division multiplexing.		
UNIT-5	**7**	**12**
Optical fibre system, system design consideration, power budget, line coding, system rise time, maximum bit rate, cannel width, electro-optic effect and applications, acousto-optic effect and applications, nonlinear effect and applications		
TOTAL	**36**	**60**

Reference books:

1. Optoelectronics – An Introduction to materials and devices; Jasprit Singh, McGraw-Hill, 1996.
2. Materials for Optoelectronics; Maurice Quillec, Springer Science, 1996.
3. Optoelectronic Devices and Systems; S. C. Gupta, Prentice Hall India, 2005.
4. Optoelectronics - An introduction; J. Wilson and J. Hawkes, Prentice-Hall India, 1996.
5. Semiconductor optoelectronic devices; P. Bhattacharya, Prentice Hall India, 2006.
6. https://nptel.ac.in/courses/115/102/115102103/

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 825 Nanotechnology		
UNIT-1 Linear vector spaces and operators	**7**	**12**
Background of nanotechnology - scientific revolutions - nanosized effects- surface to volume ratio- – atomic structure – molecules & phases – energy at the nanoscale molecular and atomic size -quantum effects- types of nanotechnology and nano machines		
UNIT-2 Vector analysis and curvilinear co-ordinates	**7**	**12**
Definition of a nano system - classification of nanocrystals - dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – top down and bottom up- Misnomers and misconception of Nanotechnology-importance of the nanoscale materials and their devices -size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity etc.		
UNIT-3 Tensors	**7**	**12**
Nanostructured materials-metal-semiconductor-ceramics and composites- size dependent properties - uniqueness in these properties compared to bulk and microscopic solids–nanomaterials and nanostructures in nature- superhydrophobicity, self-cleaning - antifogging.		
UNIT-4 Calculus of variations and Non-linear methods	**8**	**12**
Recent special nanomaterials - Carbon based nanomaterials – CNT- graphene- core-shell structures- Micro and Mesopores Materials- Organic-Inorganic Hybrids- ZnO- Silicon -- DNA- RNA- Nanoproducts		
UNIT-5 Ordinary differential equations and Special Functions	**7**	**12**
Industrial Applications of Nanomaterials: Nanoparticles and Micro –organism, Nano-materials in bone substitutes & Dentistry, Food and Cosmetic applications, Textiles, Paints, Catalysis, Drug delivery and its applications, Biochips- analytical devices, Biosensors.		
TOTAL	**36**	**60**

Reference books:

1. "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" G. Cao, Imperial College Press, 2004.
2. Nanomaterials, Nanotechnologies and Design: An introduction for engineers and Architects, Micheal F. Ashby, P.J. Ferreria, D.L. Schodek,
3. Introduction to Nanoscience and Nanotechnology, Gabor .L et al,
4. Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009
5. Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, WILE-VCH, 2008

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 827 Electrochemical Energy Storage Systems		
UNIT-1	**7**	**12**
LEAD ACID BATTERY: Advantages and disadvantages of lead acid batteries – Electrochemical reactions - Physical and chemical properties of active materials - Characteristics and properties of sulphuric acid - Constructional features - Materials and manufacturing methods - SLI (Automotive) batteries – Charge and discharge properties ties of lead acid batteries - Sealed lead acid or maintenance free batteries fabrication technology and testing - Lead acid battery for PV and automotive applications		
UNIT-2	**7**	**12**
LITHIUM-ION BATTERY: Advanced anodes and cathodes – Theoretical capacity – Merits and demerits - Nanomaterials for anodes - Carbon nanotubes - SnO_2 – NiO - TiO_2& $LiTiO_4$, - Battery fabrication technology and testing - Batteries for electric vehicles - Hybrid vehicles and solar photovoltaic applications, All-solid-state battery.		
UNIT-3	**7**	**12**
METAL-AIR BATTERY: Lithium-Air - Sodium-Air – Zinc - Air batteries - Principle – Components – anodes – Cathodes - Fabrication – Evaluation – Merits - Demerits and Applications.		
UNIT-4	**8**	**12**
FUEL CELLS: Membrane electrode assemblies – Fabrication - Catalyst layer - Fuel cell supports – GDL - Bipolar plates - Fuel cell catalysts – Precious and nonprecious metal catalysts - Bi-functional catalysts – Nanomaterials for low temperature fuel cells – Reversible fuel cells - Fuel cell stacks and systems - Fuel cells for vehicles and grid connected applications.		
UNIT-5	**7**	**12**
HYBRID ENERGY SYSTEMS: Concept of hybrid energy systems - Supercapacitors – Fundamentals and types - Battery/supercapacitors hybrid systems – Example – Applications - Hybrid fuel cell/battery systems – Example – Applications.		
TOTAL	**36**	**60**

Reference books:

1. Subramanian Srinivasan, Fuel Cells from fundamentals to applications, Springer, (2006).
2. Modern Batteries, Colin A Vincent and Bruno Scrosati, (1997) Pub Arnold ISBN 0-340-66278-6.
3. Electric Vehicle Battery Systems Sandeep Dhameja, October (2001), Pub Newnes, ISBN 0750699167.

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 829 Renewable Energy		
UNIT-1	**7**	**12**
SOLAR ENERGY: Basic concepts, solar radiation, potential of solar energy- environmental aspects of solar energy, technologies overview - Photon-to-electric energy conversion, photon-to-thermal-to-electric energy conversion, photon-to chemical energy conversion, semiconductors, solar cells, batteries, satellite solar power systems		
UNIT-2	**7**	**12**
BIOMASS ENERGY: Concepts and systems, biomass production, energy plantations, short rotation species, forestry system, biomass resource agro forestry wastes, municipal solid wastes and agro processing industrial residues, environmental factors and biomass energy development, combustion, pyrolysis, gasification and liquefaction, modeling, appliances and latest development. BIOGAS CONVERSION ENERGY: Bioconversion: biogas, fermentation and wet processes, chemicals from biomass and biotechnology. Biodiesel, ethanol, methanol, manufacture properties and uses.		
UNIT-3	**7**	**12**
WIND ENERGY: Energy and power in wind - wind turbines - power and energy from wind turbines - commercial development and wind energy potential - economics -cost calculation – capital cost. Wave Energy - wave motion - power from wave energy GEOTHERMAL AND WAVE ENERGY: Geothermal energy, types, systems and applications, ocean thermal energy, systems and applications. Wave energy systems and applications. Tidal energy - systems and applications.		
UNIT-4	**8**	**12**
HYDROELECTRICITY: Stored potential energy - power head and flow rate - world resource - types of hydroelectric plants - low, medium and high heads - estimation of power - economics of hydroelectric projects. Tidal Power -Nature of resource - basic physics - power generation -economical and environmental factors. Ocean Thermal Energy Conversion (OTEC) Introduction – OTEC power generation.		
UNIT-5	**7**	**12**
HYDROGEN ENERGY & FUEL CELLS: Design and principle of operation of a Fuel Cell (H_2, O_2 cell), Classification of Fuel Cells, Types of Fuel Cells, Advantages and Disadvantages of Fuel Cells, Conversion efficiency of Fuel Cells, Work output and EMF of Fuel Cells, Applications of Fuel Cells-Hydrogen Energy, Hydrogen production (Electrolysis method, Thermo-chemical methods, Fossil fuel methods, solar energy methods), Hydrogen storage, Hydrogen transportation, Utilization of Hydrogen Gas, Safety and management, Hydrogen technology development.		
TOTAL	**36**	**60**

Reference books:

1. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme,2nd Ed. TMH
2. Solar energy, H. P. Garg and J Prakashi, TMH 1997
3. Renewable Energy Source and Conversion Technology, N.K Bansal, M. Kleemanm & M. Melss, TMH.
4. Renewable Energy, Godfrey Boyle, Oxford Univ. Press, 1996

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 831 Vacuum Science and Thin Film Technology		
UNIT-1	**7**	**12**
Vacuum Science: Kinetic theory of gases: Atomistic concept of gas pressure and temperature, Molecular distribution functions, Impingement rate of molecules on a surface, Free path of gas molecules, Gas viscosity and flow, gas conductance of a vacuum line, gas impedance of a vacuum line, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes		
UNIT-2	**7**	**12**
Production of Vacuum: Meaning of vacuum and vacuum measuring units, vacuum ranges, pumping speed and pump down time. Vacuum Pumps: Mechanical pumps (Oil sealed rotary pump, Roots Pump, Molecular drag pump), Diffusion pump (Operating principles, back streaming, traps and baffles, performance ranges), Cryosorption pumps, Getter pumps (Chemical cleanup and sublimation pumps, Electrical cleanup and ion pumps, Evapour ion pumps, Sputter ion pumps, Titanium sublimation pump.		
UNIT-3	**7**	**12**
Vacuum Measurements: Measurement of low pressure Pressure gauges for low to high vacuum, Mc Leod manometer, Thermal conductivity gauges, Pressure gauges for high to ultrahigh vacuum, Hot cathode ionization gauges, Cold cathode ionization gauges, Operation of High-vacuum gauges. Vacuum Applications: Applications in science, technology, research, space science, medical science, day to day life. Use of vacuum in particle accelerators.		
UNIT-4	**8**	**12**
Thin Film technology: Nucleation and Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories: Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure; Structural defects and their incorporation. Properties of thin films: Electrical, mechanical, optical and magnetic.Introduction – OTEC power generation.		
UNIT-5	**7**	**12**
Preparation methods: Electrochemical Deposition (ECD); Spin coating; Physical Vapor Deposition (PVD)- thermal evaporation, electron beam evaporation, rf-sputtering; Pulsed Laser deposition (PLD); Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD (PECVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE). Thickness measurement and monitoring: Electrical, mechanical, optical interference, microbalance, quartz crystal methods.		
TOTAL	**36**	**60**

Reference books:

1. Handbook of Thin Film Technology, L. I. Maissel and R. Glang, Mc Graw Hill Book Co. 1970, 07-039742-2
2. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.
3. Vacuum Technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
4. High Vacuum Techniques, J. Yarwood, (Chapman and Hall, London, 1967
5. Thin film Phenomena, by K.L. Chopra, Mcgraw-Hill Book Company

Credits 4 (L:T:P = 3:1:0) **Semester: III** **Program Core**

Topic and Contents	Hours	Marks
SC 814 Intellectual Property Rights IPR		
UNIT-1	**7**	**12**
Introduction and the need for intellectual property right (IPR) – Kinds of Intellectual Property Rights; International Conventions including TRIPS Agreement WIPO, UCC, Paris Union, Berne Convention, UNESCO. Patents :- Introduction & concepts, Historical Overview; Subject matter of patent; Kinds of Patents; Development of Law of Patents through international treaties and conventions including TRIPS Agreement; Procedure for grant of patents & term of Patent; Surrender, revocation and restoration of patent; Rights and obligations of Patentee; Grant of compulsory licenses; Infringement of Patent and legal remedies; Offences and penalties; Discussion on leading cases.		
UNIT-2	**7**	**12**
Meaning of Copyright, Historical Evolution; Subject matter of copyright; Literary works; Dramatic Works & Musical Works; Computer Programme; Cinematographic films; Registration of Copyrights; Term of Copyright and Ownership of Copyrights; Neighboring Rights; Rights of Performers & Broadcasters; Assignment of Copyright; Author's Special Rights (Moral Rights); Infringement of Copyrights and defenses; Remedies against infringement (Jurisdiction of Courts and penalties);		
UNIT-3	**7**	**12**
Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.		
UNIT-4	**8**	**12**
Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. Plant variety protection: meaning and benefit sharing and farmers'rights – Procedure for registration, effect of registration and term of protection. Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection		
UNIT-5	**7**	**12**
India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.		
TOTAL	**36**	**60**

Reference books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES
M.Sc. (Physics)
Academic session 2021-23

DETAILED SYLLABUS

Course Title: **CLASSICAL MECHANICS**		Course Code	: SC 801
Semester	: **I**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mechanics.

Course Objectives:

The course has three major objectives.

To understand the drawbacks of Newtonian approach and necessity of new approaches to solve advanced problems involving the dynamic motion of classical mechanical systems.
To introduce about the forces, angular momentum and knowledge about the constraint.
To use differential equations and other advanced mathematics in the solution of the problems.
To use conservation of energy and linear and angular momentum to solve dynamics problems.
To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Newtonian mechanics of one and many particle systems, Simple pendulum with rigid support, Two connected masses with string passing over a pulley, Virtual work, Rolling mass inside and outside a circular ring, Constraints, holonomic and non-holonomic constraints, D'Alembert's Principle and Lagrange's Equation, velocity dependent potentials, simple applications of Lagrangian formulation.		
UNIT-2	**7**	**12**
Hamilton Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle. Extension of Hamilton's Principle for nonconservative and nonholonomic systems, Method of Lagrange's multipliers, Conservation theorems and Symmetry Properties, Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space.		
UNIT-3	**7**	**12**
Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivationof Hamilton's canonical Equation from Hamilton's variational principle. The principle of least action.		
UNIT-4	**8**	**12**
Canonical transformation, integral invariant of Poincare: Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's theorem, Hamilton-Jacobi equation and its application.		

UNIT-5	**7**	**12**
Action angle variable adiabatic invariance of action variable: The Kepler problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and its applications. Orthogonal transformation, Euler's theorem, Eigenvalues of the inertia tensor, Euler equations, force free motion of a rigid body.		
TOTAL	**36**	**60**

Text Book:

1. Herbert Goldstein, Charles Poole, John Safko, Classical Mechanics, Perason Education
2. A. Ray choudhary, Classical Mechanics, Oxford University Press
3. N. C. Rana and P. S. Joag Classical Mechanics, Tata McGraw Hill.
4. J.C. Upadhyaya, Classical Mechanics< Himalaya Publishing House.
5. https://nptel.ac.in/courses/115/106/115106123/
6. https://nptel.ac.in/courses/115/106/115106068/

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

Have a deep understanding of Newton's laws.

Students will be able to define and understand basic mechanical concepts related to advanced problems involving the dynamic motion of classical mechanical systems.

Students will be able to describe and understand the motion of a mechanical system using Lagrangen Hamilton formalism.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	S
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	

		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **QUANTUM MECHANICS**		Course Code	: SC 803
Semester	: **I**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

Allstudentsareexpectedto havea generalknowledgeof Quantum mechanics.

Course Objectives:

The course has three major objectives.

To acquire mathematical skills require to develop theory of quantum mechanics.

To develop understanding of postulates of quantum mechanics and to learn to apply them to solve some quantum mechanical systems.

To offer systematic methodology for the application of approximation methods to solve complicated quantum mechanical systems

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Formulation of Quantum Mechanics: Review of quantum postulates, Mathematical properties of linear vector spaces, postulates of quantum mechanics. Eigenvalues and eigenvectors, orthonormality, completeness, closure. Dirac's bra and ket notation. Matrix. representation of operators. Position and momentum representations- connection with wave mechanics. Commuting operators. Generalized uncertainty principle. Change of basis and unitary transformations. Expectation values, Ehrenfest theorem.		
UNIT-2	**7**	**12**
Schrodinger picture, Heisenberg picture. Heisenberg equation of motion. Classical limit. Solution of harmonic oscillator problem by the operator method. Symmetries in quantum mechanics: general views of symmetries. Spatial translation- continuous and discrete. Time translation, parity, and Time reversal. Angular Momentum: Commutation relations of angular momentum operators. Eigen values and eigen functions. Ladder operators and their matrix representations. Addition of angular momenta. Clebsch-Gordan coefficients.		
UNIT-3	**7**	**12**
Approximation methods for stationary systems: Time independent perturbation theory: non-degenerate and degenerate. Applications to Zeeman effect, isotropic shift, and Stark effect. Approximation methods for time dependent problems: Interaction picture. Time dependent perturbation theory. Transition to a continuum of final states- Fermi's Golden rule.		
UNIT-4	**8**	**12**
Scattering Theory: Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.		
UNIT-5	**7**	**12**
Klein-Gordon and Dirac equations. Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin orbit coupling. Energy levels in a Coulomb field		
TOTAL	**36**	**60**

Text Book:

1. **Text**S Flugge, Quantum Mechanics, Springer
2. D.J. Griffith, Introduction to Quantum Mechanics, Cambridge University Press.
3. Quantum Physics by H.C. Verma, TBS Publications.
4. R.Shankar, Principles of Quantum Mechanics, Springer.
5. L.I. Schiff, Quantum Mechanics, Mc-Graw Hill.
6. https://nptel.ac.in/courses/115/104/115104096/
7. https://nptel.ac.in/courses/115/101/115101107/

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

Understand historical aspects of development of quantum mechanics.
Understand and explain the differences between classical and quantum mechanics.
Understand the central concepts and principles in quantum mechanics.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	M	M
2	S	S	S	S	S	M
3	S	S	S	S	S	S

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

S. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **MATHEMATICAL PHYSICS**		Course Code	: SC 805
Semester	: **I**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of solids and their properties.

Course Objectives:

The course has three major objectives.

Student should be able to understand basic theory of Complex Analysis, Linear Algebra, Matrix algebra, Special functions, Fourier series and integral transforms.

To learn mathematical tools required to solve physical problem.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Coordinate transformations, scalars, contravariant and covariant vectors, definition of contra varient, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors, quotient rule. Christoffel symbols, transformation of Christoffel symbols, covariant differentiation, Ricci's theorem, divergence, Curl and Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form.		
UNIT-2	**7**	**12**
Separation of variables-ordinary differential equations, singular points, series solutions leading to Legendre, Bessel, Hermite, Laguerre functions as solutions. Orthogonal properties and recurrence relations of these functions. Spherical harmonics and associated Legendre polynomials. Hermite polynomials. Sturm-Liouville systems and orthogonal polynomials. Wronskian-linear independence and linear dependence.		
UNIT-3	**7**	**12**

Functions of complex variable, Limits and continuity, differentiation, Analytical functions, Cauchy- Riemannn conditions, Cauchy Integral theorem, Cauchy integral formula, Derivatives of analytical functions, Liouville's theorem. Power series Taylor's theorem, Laurent's theorem. Calculus of residues –poles, essential singularities and branch points, residue theorem, Jordan's lemma, singularities on contours of integration, evaluation of definite integrals.		
UNIT-4	**8**	**12**
Fourier Transforms: Development of the Fourier integral from the Fourier Series, Fourier and inverse Fourier transform: Simple Applications: Finite wave train, Wave train with Gaussian amplitude, Fourier transform of derivatives, solution of wave equation as an application. Convolution theorem. Intensity in terms of spectral density for quasi monochromic EM Waves, Momentum representation.		
UNIT-5	**7**	**12**
Application of Fourier transform to diffraction theory: diffraction pattern of one and two slits. Laplace transforms and their properties, Laplace transform of derivatives and integrals, derivatives and integral of Laplace transform. Convolution theorem. Impulsive function, Application of Laplace transform in solving linear, differential equations with constant coefficient with variable coefficient andlinear partial differential equation		
TOTAL	**36**	**60**

Text Books

1. Mathematical Physics by P K Chattopadhyay, Wiley Eastern Lit., Mumbai
2. Introduction to Mathematical Physics by C Harper, PHI
3. Mathematical Physics by Satya Prakash, S Chand and Sons, New Delhi
4. https://nptel.ac.in/courses/115/106/115106086/
5. https://nptel.ac.in/courses/115/105/115105097/

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

1. Have a good grasp of the basic elements of complex analysis, including the important integral theorems. Students will be able to determine the residues of a complex function and use the residue theorem to compute certain types of integrals.
2. Have learned how to expand a function in a Fourier series, and under what conditions such an expansion is valid. Students will be aware of the connection between this and integral transforms (Fourier and Laplace).

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40
Course	Course Code : SC 807	

Semester	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P) **: 3:1:0**	Credits	: **4 Credits**
Type of course : **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation : **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**		

Pre-requisites:

All students are expected to have a general knowledge of particles.

Course Objectives:

The course has three major objectives.

This course in statistical mechanics provides the basic idea of probability to the students.

The objective is to apply the principles of probability in distribution of particles in various systems and to calculate thermodynamic probability.

Students will learn the different types of statistics distribution and particles. They will learn which particles follow which statistics and why.

Course Content:

Topic and Contents	Hours	Marks

UNIT-1	7	12
Elementary probability theory: Preliminary concepts, Random walk problem, Binomial distribution, mean values, standard deviation, various moments, Gaussian distribution, Poisson distribution, mean values. Probability density, probability for continuous variables.		
UNIT-2	**7**	**12**
Extensive and intensive variables, laws of thermodynamics, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) dielectric material. The laws of thermodynamics and their consequences.		
UNIT-3	**7**	**12**
Statistical description of system of particles: State of a system, microstates, ensemble, basic postulates, behavior of density of states, density of state for ideal gas in classical limit, thermal and mechanical interactions, quasi-static process. Statistical thermodynamics: Irreversibility and attainment of equilibrium, Reversible and irreversible processes. Thermal interaction between macroscopic systems, approach to thermal equilibrium, dependence of density of states on external parameters, Statistical calculation of thermodynamic variables.		
UNIT-4	**8**	**12**
Classical statistical mechanics: Microcanonical ensembles and their Equivalence, Canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition function and grand partition function, ideal gas, Gibbs paradox, validity of classical approximation, equipartition theorem. Maxwell-Boltzmann gas velocity and speed distribution. Chemical potential, Free energy and connection with thermodynamic variables, First and Second order phase transition.		
UNIT-5	**7**	**12**
Formulation of quantum statistics, Density Matrix, ensembles in quantum statistical mechanics, simple applications of density matrix. The theory of simple gases: Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac gases. Statistics of occupation numbers, Evaluation of partition functions, Ideal gases in the classical limit. Ideal Bose system: Thermodynamic behavior of an Ideal Bose gas, Bose-Einstein condensation. Thermodynamics of Black body radiation, Stefan-Boltzmann law, Wien's displacement law. Specific heat of solids (Einstein and Debye models). Ideal Fermi System: Thermodynamic behavior of an ideal Fermi gas, degenerate Fermi gas, Fermi energy and mean energy, Fermi temperature, Fermi velocity of a particle of a degenerate gas..		
TOTAL	**36**	**60**

Text books:

1. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill.
2. R. K. Pathria, Statistical Mechanics, Pergamon Press.
3. B. B. Laud Fundamentals of Statistical Mechanics, New Age.
4. https://nptel.ac.in/courses/115/103/115103113/
5. https://nptel.ac.in/courses/115/106/115106111/

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

1. After taking this course students are able to determine the probability of any type of events. They are able to interpret different types of events.

2. Students have understood the concept of phase space and its volume.
3. They can easily distinguish between different types of particles and statistics and can easily distribute bosons, fermions and classical particles among energy levels.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)

1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **ELECTRODYNAMICS AND ELECTROMAGNETIC THEORY**		Course Code	: SC 802
Semester	: **II**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a basic knowledge of mechanics.

Course Objectives:

To aspire the students regarding the computation of vector potential, electric field of a localized current distribution using multiple expansion problems.
To acquaint the students regarding the concepts of electrodynamics and Maxwell equations and apply it in numerous problems

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Electric field, Gauss Law, Differential form of Gaussian law. Surface distribution of charges and dipoles and discontinuities in the electric field and potential, Poisson and Laplace equations, Green's Theorem, Formal Solutions of electrostatic boundary value problem with Green's function, Electrostatic potential energy and energy density, capacitance.		
UNIT-2	**7**	**12**
Boundary Value Problems in Electrostatics: Methods of Images, Point charge at different conditions, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential, conducting sphere with hemispheres at a different potentials, orthogonal functions and expansion.		
UNIT-3	**7**	**12**
Multipole expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment ofelectrostatics with permeable media. Boundary value problems with dielectrics. Molar polarizability and electric susceptibility. Models for molecular polarizability, electrostatic energy in dielectric media.		
UNIT-4	**8**	**12**
Time varying fields, Maxwell's equations, conservation laws: Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, coulomb gauge, Green function for the wave equation, Derivation of the equations of Macroscopic Electromagnetism, Poynting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields. Conservation laws for macroscopic media.		
UNIT-5	**7**	**12**
Lorentz' transformations; Group symmetries of Lorentz' transformations, Electromagnetic field tensor, Relativistic electrodynamics using potential, Four vector formalism, Relativistic energy and momentum, transformation of four potentials and four currents, Relativistic transformations of electro-magnetic fields, Maxwell's equations in covariant form. Invariance of electric charge, covariance of electrodynamics.		
TOTAL	**36**	**60**

Reference books:

1. J.D. Jackson: Classical Electrodynamics, Wiley
2. David J. Griffiths: Introduction to Electrodynamics, Benjamin Cummings
3. L.D. Landau and E.M. Lifshitz, Classical Theory of Electrodynamics, Addison-Wesley.
4. L.D. Landau and E.M. Lifshitz, Electrodynamics of Continuous Media,Addison-Wesley.
5. https://nptel.ac.in/courses/115/106/115106122/

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

1. Use Maxwell equations in analysing the nature of electromagnetic field due to time varying charge and current distribution.
2. Describe the nature of electromagnetic wave and its propagation through different media and interfaces involved in different situations.
3. Simplify charged particle dynamics and radiation from localized time varying electromagnetic sources.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **CONDENSED MATTER PHYSICS**		Course Code	: SC 804
Semester	: **II**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of physics of atoms and molecules.

Course Objectives:

The course has three major objectives.

To study some of the basic properties of the condensed phase of matter especially solids. Condensed matter physics (CMP) is the fundamental science of solids and liquids.

As the largest branch of physics, it has the greatest impact on our daily lives by providing foundations for technology developments.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Crystal solids, unit cells, two- and three-dimensional Bravais lattices, crystal systems, crystal planes and Miller indices, close packed structures, symmetry elements in crystals, point groups and space groups, crystal structure factor and determination: X-ray, electron and neutron diffraction, Ewald construction, reciprocal lattices and its applications to diffraction techniques.		
UNIT-2	**7**	**12**
Bonding in crystal: the van der Waals bond, cohesive energy of inert gas solids, ionic bond, cohesive energy and bulk modulus of ionic crystals, Madelung constant, the covalent bond, metallic bond; defects in crystals: point defects, line defects, Burger's vector, dislocation density, surface defects, grain boundaries and stacking faults.		
UNIT-3	**7**	**12**
Thermal conductivity of solids: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; quantization of lattice vibrations, the concept of phonons and quantization; phonon momentum, inelastic scattering of neutrons by phonons, surface vibrations. Brillouin zones.		
UNIT-4	**8**	**12**
Thermal expansion, Boltzmann's transport equation, electrical and thermal conductivities of solid, Wiedemann-Franz law, Free electron theory of metals; Hall effect in metal, electrons in periodic lattice: Bloch theorem, the Kronnig- Penney model, band theory, classification of solids on the basis of band theory, effective mass of electron and hole, Fermi surface and Fermi gas, Fermi level, carrier concentration in extrinsic and intrinsic semiconductors..		
UNIT-5	**7**	**12**
Superconductivity and its historical perspective, critical temperature, type-I and type II superconductors, persistent current, effect of magnetic field, Meissner effect, thermodynamics of superconductors.		
TOTAL	**36**	**60**

Text Books

1. M.L. Cohen, Fundamentals of Condensed Matter Physics.
2. A. Aharony, Introduction to Solid State Physics, World Scientific.
3. P. M. Chaikin, Principles of Condensed Matter Physics, Cambridge University Press.
4. Charles Kittle, Introduction to Solid State Physics, Wiley

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

Basic structures, packing fraction, Millar indices, Brillion zones, Defect in solids using X-ray diffraction. Energy well, Bloch function, construction of Fermi surfaces, calculation of band gap energy, direct and indirect semiconductors, effective mass, rectifier, Scottky barrier.

Different types of polarizations, Dielectric constant, relaxation time, Dielectric loss. Missner's effect, London theory, Properties of superconductor, flux quantization, BCS theory, high Tc superconductors.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **ADVANCED ELECTRONICS**		Course Code	: SC 806
Semester	: **II**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of particles.

Course Objectives:

The course has three major objectives.
Students should understand the concepts of:
1. Special function ICs
2. Regulated power supply
3. Digital Logic circuits
4. Data Converters.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Synthesis of two terminal reactive networks – Driving point impedance and admittance, Foster's reactance theorems, properties of poles and zeros of reactance function, canonic networks. Four-terminal two-port network – parameters for symmetrical and unsymmetrical networks; image, iterative and characteristic impedances; propagation function; lattice network; Bisection theorem and its application. Filters and Attenuators.		
UNIT-2	**7**	**12**
p-n junction physics- Fabrication steps; thermal equilibrium condition; depletion capacitance; current-voltage characteristics; charge storage and transient behavior; junction breakdown; heterojunction. Characteristics of some semiconductor devices- BJT, JFET, MOS, LED, Solar cell, Tunnel diode, Gunn diode and IMPATT.		
UNIT-3	**7**	**12**
Differential amplifier; circuit configurations; dual input, balanced output differential amplifier; DC analysis; AC analysis; inverting and non-inverting inputs; CMRR; constant current bias level transistor. Block diagram of a typical Op-Amp analysis. Open loop configuration inverting and noninverting amplifiers. Op-amp with negative feedback; voltage series feedback; effect of feedback on closed loop gain, input resistance, output resistance; bandwidth and output offset voltage; voltage follower. Practical Op-amp; input offset voltage; input bias current; input offset current; total output offset voltage; CMRR frequency response.		
UNIT-4	**8**	**12**
Combinational Logic: The transistor as a switch, OR, AND and NOT gates, NOR and NAND gates; Boolean algebra; Demorgan's theorems; Exclusive OR gate; Adder, Decoder/Demultiplexer; Data selector/multiplexer; Encoder. Sequential Logic: Flip-Flops: A 1-bit memory; The RS Flip-Flop; JK Flip-Flop; JK master slave Flip-Flop; T Flip-Flop; D Flip-Flop; Shift registers; synchronous and asynchronous counters; cascade counters...		
UNIT-5	**7**	**12**
Op-Amp Circuits: Characteristics of ideal and practical op-amp; Nonlinear amplifiers using op-amps- log amplifier, anti-log amplifier, regenerative comparators; Active filters; precision rectifiers; ADC and DAC circuits; Op-amp based self oscillator circuits- RC phase shift, Wien bridge, non-sinusoidal oscillators		
TOTAL	**36**	**60**

Reference Books

1. The art of electronics, Paul Horowitz and Winfield Hill, (Second Edition, 1992), Foundation Books, New Delhi.
2. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
3. Digital principles and applications, Donald P Leach and Albert Paul Malvino, (Fifth Edition, 2002), Tata McGraw Hill.

Course outcomes:

On successful completion of the course:

Students who have studied this course should:

Use special function ICs for different applications.
Built and design regulated power supply.
Develop logic circuits for various applications in real life.
Design and develop data convertors.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M
4	S	S	S	S	S	S

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **ATOMIC AND MOLECULAR PHYSICS**		Course Code	: SC 808
Semester	: **II**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of electronics.

Course Objectives:

The subject of Atomic and Molecular Physics has reached a significant advancement in high– precision experimental measurement techniques.
This area covers a wide spectrum ranging from conventional to new emerging multidisciplinary areas like molecular physics, optical science especially spectroscopy.
In the present syllabus sequence of articles in each chapter enables the student to understand the gradual development of the subject..

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Atomic Structure and Atomic Spectra Rutherford's Model and concept of stability of atom, Bohr'smodel, Sommerfeld's model, Stern-Gerlach experiment for electron spin, Revision of quantum numbers, exclusion principle, electron configuration, Hund's rule etc..		
UNIT-2	**7**	**12**
Gross structure of energy spectrum of hydrogen atom. Nondegenerate first order perturbation method, relativistic correction to energy levels of an atom, atom in a weak uniform external electric field – first and second order Stark effect, calculation of the polarizability of the ground state of hydrogen atom and of an isotropic harmonic oscillator; degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels.		
UNIT-3	**7**	**12**
Orbital magnetic dipole moment, spin-orbit interaction energy, Hartree theory, LS coupling, origin of spectral lines, selection rules, some features of one-electron, two-electron spectra and X-ray spectra, fine spectra, hyperfine structure, Zeeman effect. Lamb shift (only qualitative description)		
UNIT-4	**8**	**12**
The nature of chemical bonds, valence bond approach and molecular orbital approach for molecular bonding (for H2 molecule). Bonding and antibonding orbitals, pi- bonds, sigma - bonds, different kinds of bonding mechanism, Madelung constant, hybridization, bonding in hydrocarbons		
UNIT-5	**7**	**12**
Molecular spectra: Rotational levels in diatomic and polyatomic molecules, vibrational levels in diatomic and polyatomic molecules, diatomic vibrating rotator, Born-Oppenheimer approximation, symmetry of the molecules and vibrational levels, experimental aspects of vibrational and rotational spectroscopy of molecules, polarization of light and Raman effect, Raman Spectroscopy..		
TOTAL	**36**	**60**

Reference books:

1. Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.
2. H. E. White, Introduction to Atomic Spectra, McGraw Hill.

3. Arthur Beiser, Perspectives of Modern Physics, McGraw Hill.
4. Gerhard Herzberg Molecular Spectra and Molecular Structure, Krieger Pub Co.
5. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
6. https://nptel.ac.in/courses/115/105/115105100/

Course outcomes:

Students will have understanding of:

Describe theories explaining the structure of atoms and the origin of the observed spectra. Identify atomic effect such as Zeeman effect and Stark effect.

List different types of atomic spectra.

Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **NUCLEAR AND PARTICLE PHYSICS**		Course Code	: SC 811
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of Solid state physics.

Course Objectives:

The course has three major objectives.

The objective of the course is to appraise the students about the particles .
To learn about the decay phenomenon and the process how they will occur.
Knowledge of various model compare to nucleus.
Knowledge of scattering process..

CourseContent:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Properties of Nucleus & Nuclear Forces: Shape and size, mass and relative abundances, spin and parity, binding energy & nuclear stability, nuclear compositions, quantum properties of nucleon states, radioactivity: laws of radioactivity, radioactive dating, radioactive series.		
UNIT-2	**7**	**12**
Theory of alpha, beta & gamma decays and their properties, nuclear forces: properties of nuclear forces, two nucleon systems deuteron with potentials, n-p and p-p/n-n interactions at different energies, exchange forces and tensor forces, Yukawa's hypothesis, meson theory of nuclear force, Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations) Reduced transition probability, Selection rules; Internal conversion and zero-zero transition		
UNIT-3	**7**	**12**
Fermi gas model, liquid drop model and Bethe-Weizsacker formula, their applications; shell model and shell structure, extreme single particle shell model with potentials – square well, harmonic oscillator; spin orbit interaction, magic numbers, predictions of the shell model; collective nuclear model; superconductivity model (qualitative idea only), Collective Nuclear Models and characteristics.		
UNIT-4	**8**	**12**
Types of nuclear reactions and conservation laws, nuclear reaction kinematics, nuclear scattering cross section determinations, compound nucleus disintegration, Breit Wigner dispersion formula (one level), direct reactions, nuclear transmutation reactions, nuclear fission and fusion, partial wave analysis of reaction cross section, compound nucleus formation and breakup, resonance scattering and reaction-Briet –Weigner dispersion formula for s-waves (l=0), continuum cross section, statistical theory of nuclear reactions		
UNIT-5	**7**	**12**

General characteristics of weak interaction; nuclear beta decay and lepton capture; electron energy spectrum and Fermi-Kurie plot; Fermi theory of beta decay (parity conserved election rules Fermi and Gamow-Teller) for allowed transitions; ft-values; General interaction hamiltonian for beta decay with non-conserving terms; Forbidden transitions; Experimental verification of parity violation.		
TOTAL	**36**	**60**

Reference books:

1. J.M. Bhatt and V.E. Weisskipf : Theoretical Nuclear Physics.
2. L.R.B. Elton : Introductory Nuclear Theory (ELBS Publicatio, London, 1959).
3. B.K. Agarwal : Nuclear Physics (Lokbharti Publication Allahabad. 1989).
4. R.R. Roy and B.P.Nigam : Nuclear Physics (Willey -Easter, 1979).
5. M.A. Preston & R.K. Bhaduri : Structure of the Nucleus (Addition-Wesley, 1975).
6. https://nptel.ac.in/courses/115/103/115103101/

Course outcomes:

Students who have studied this course should

Students shall learn about the knowledge of particles.
Significance of various decays tells the students about the nuclear process.
It will teach the students about the spin parity concept &magic no. related to shell.
About the scattering process how it will occur

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M
4	S	S	S	S	S	S

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		

	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **EXPERIMENTAL TECHNIQUES IN PHYSICS**		Course Code	: SC 813
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of principle of electronics.

Course Objectives:

The course has three major objectives.

- To teach scholars some of the basic concepts of experimental methods of physics in research.
- To prepare them for research in advanced fields of experimental physics

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Measurement of low resistance: two probe, three probe and four probe methods, Lock-in amplifier; measurement of capacitance High frequency measurements.Basic concepts, design of vacuum chamber, pumps; measurement of pressure: Gauges. Production of low temperature, measurement of low temperature. Low temperature device construction.		
UNIT-2	**7**	**12**
Sources of Electromagnetic Radiations: Different types of radiations (X-rays, UV-VIS, IR, microwaves and nuclear) and their sources. Detectors: X-rays, UV-VIS, IR, microwaves and nuclear detectors. Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, dielectric, acoustic, thermal, optical, mechanical, pressure, IR, UV, gas and humidity with examples..		
UNIT-3	**7**	**12**
X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Laue's method, Rotating crystal method, Powder (DebyeScherrer) method, Derivation of Scherrer formula for size determination, Neutron Diffraction: Principle, Instrumentation and Working. Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors. Numericals.		
UNIT-4	**7**	**12**
Optical Microscopy: Principle, Instrumentation and Working of optical microscope Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED) Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM) Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle, Instrumentation and Working. Numericals.		
UNIT-5	**8**	**12**

Spectroscopic characterization (principle, instrumentation and working): InfraRed (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray photoelectron spectroscopy (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR). Numericals.		
TOTAL	**36**	**60**

Reference Books

1. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
2. Instrumental Methods of Chemical Analysis, G.Chatwal & S.Anand, Himalaya Publishing House.
3. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers.
4. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, (1992)
5. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001).
6. https://nptel.ac.in/courses/115/105/115105110/
7. https://nptel.ac.in/courses/115/105/115105120/
8. https://nptel.ac.in/courses/115/105/115105121/

Course outcomes:

Students who have studied this course should

Describe modern experimental methods in materials physics
Name the limitations of the respective techniques.
Judge the precision and accuracy of the measurements.
Choose the right technique to address specific material physics questions.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M
4	S	S	S	S	S	S

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	

				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **MICROWAVE ELECTRONICS**		Course Code	: SC 821
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of experimental physics.

Course Objectives:

The course has three major objectives.

Information about Transmission lines and wave-guides.
The design and working of various types of micro-wave sources
Information about various types of stripline, microstrip lines and Network analysis.
Knowledge about Micro-wave passive components and methods to measure various microwave parameters are planned
Information about design, fabrication and working of microwave integrated circuit technology.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Introduction to microwaves and its frequencies spectrum Application of microwaves. Wave Guides ☹a) Rectangular wave guides: Wave equation & its solutions, TE & TM modes. Dominant mode and choice of wave guide Dimensions Methods of excitation of wave guide. (b) Circular wave guide-wave equation & it solutions, TE, TM & TEM modes. (c) Attenuation – Cause of attenuation in wave guides, wall current. & derivation of attenuation constant, Q of the wave guide..		
UNIT-2	**7**	**12**
Resonators: Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter).		
UNIT-3	**7**	**12**
Ferrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators. Microwave tubes: Space.		
UNIT-4	**8**	**12**
Magnetrons: Types & description, Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics. Traveling wave tubes: O & M type traveling wave tubes. Gyrotorons: Constructions of different Gyrotrons, Field – Particle Interaction in Gyrotron		
UNIT-5	**7**	**12**
Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, Coupling using direction coupler. Complex ermittivity of material & its measurement: definition of complex of solids, liquids and powders using shift of minima method.		
TOTAL	**36**	**60**

Reference Books

1. Electromagnetic Waves & Radiating System-Jorden & Balmain.

2. Theory and Applications of Microwaves A.B. Brownwell & R.E. Beam (Mc Graw Hill).
3. Introduction to Microwave Theory by Atwater (McGraw Hill).
4. Principles of Microwave circuits by G.C. Montogmetry (McGraw Hill).

Course outcomes:

Students who have studied this course should

Leaner would gain knowledge about working, design and application of microwave frequency electronics. The course is intended to enrich the learner about Microwave transmission lines and waveguides. Through it students would be able to understand the propagation of microwave through transmission lines and Waveguides.

Learner would gather understanding of devices used for microwave generation, detection and microwave network analysis.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **OPTOELECTRONICS**		Course Code	: SC 823
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

Understanding basic laws and phenomena in the area of Optoelectronics and Lasers.
Theoretical and practical preparation of students to acquire and apply knowledge and skills in Optoelectronics and Lasers.
Conducting experiments in laboratory and industrial environment

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Semiconducting materials and Heterostructures; Electronic, transport and optical properties of semiconductors: Direct and Indirect bands; Degenerate and non-degenerate semiconductors, Doping and degeneracy; Allowed, forbidden and phonon assisted optical transitions; Switching; Colour centres; Photoconductivity; Internal quantum efficiency, External quantum efficiency; Double heterojunction, Fabrication of heterojunction, Quantum wells and superlattices.		
UNIT-2	**7**	**12**
LEDs (spontaneous emission, LED structure-surface emitting, Edge emitting-Injection efficiency, recombination efficiency, LED characteristics, spectral response, modulation, Band width, Laser diodes, Basic principle, condition for gain-Laser action-population inversion-stimulated emission, Injection Laser diode, structure, temperature effects, modulation, comparison between LED and ILDs.		
UNIT-3	**7**	**12**
Optical detectors-optical detector principle, absorption coefficient, detector, characteristics, Quantum efficiency, responsivity, response time-bias voltage, Noise in detectors P-N junction-photo diode, characteristics, P-I-N-photo diode, response, Avalanche photo diode (APD) multiplication process-B,W-Noise photo transistor.		
UNIT-4	**8**	**12**
Optical Fibre, structure, advantages, Types-propagation-wave equation, phase and group velocity, transmission characteristics, attenuation-absorption, scattering losses-dispersion, fibre bend losses, source coupling, splices and connectors-wave length division multiplexing		
UNIT-5	**7**	**12**
Optical fibre system, system design consideration, power budget, line coding, system rise time, maximum bit rate, cannel width, electro-optic effect and applications, acousto-optic effect and applications, nonlinear effect and applications.		
TOTAL	**36**	**60**

Text books:

1. Optoelectronics – An Introduction to materials and devices; Jasprit Singh, McGraw-Hill, 1996.
2. Materials for Optoelectronics; Maurice Quillec, Springer Science, 1996.

3. Optoelectronic Devices and Systems; S. C. Gupta, Prentice Hall India, 2005.
4. Optoelectronics – An introduction; J. Wilson and J. Hawkes, Prentice-Hall India, 1996.
5. Semiconductor optoelectronic devices; P. Bhattacharya, Prentice Hall India, 2006.
6. https://nptel.ac.in/courses/115/102/115102103/

Course outcomes:

Students who have studied this course should

Explain fundamental physical and technical base of Optoelectronic systems.
Describe basic laws and phenomena that define behaviour of optoelectronic systems. Analyse various premises, approaches procedures and results related to optoelectronic systems.
Use optical fibre equipment, and data transfer using optical fiber.
Conduct experiments and measurements in laboratory and on real components, devices and equipment of optoelectronic systems.
Interpret the acquired data and measured results.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M
4	S	S	S	S	S	S
5	S	S	S	S	S	S

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **NANOTECHNOLOGY**		Course Code	: SC 825
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

To provide an intensive and in-depth learning to the students in field of Nanotechnology.
Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Background of nanotechnology - scientific revolutions - nanosized effects- surface to volume ratio- – atomic structure – molecules & phases – energy at the nanoscale molecular and atomic size -quantum effects- types of nanotechnology and nano machines		
UNIT-2	**7**	**12**
Definition of a nano system - classification of nanocrystals - dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – top down and bottom up- Misnomers and misconception of Nanotechnology-importance of the nanoscale materials and their devices -size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity etc.		
UNIT-3	**7**	**12**
Nanostructured materials-metal-semiconductor-ceramics and composites- size dependent properties - uniqueness in these properties compared to bulk and microscopic solids–nanomaterials and nanostructures in nature- superhydrophobicity, self-cleaning - antifogging.		
UNIT-4	**8**	**12**
Recent special nanomaterials - Carbon based nanomaterials – CNT- graphene- core-shell structures- Micro and Mesopores Materials- Organic-Inorganic Hybrids- ZnO- Silicon -- DNA-RNA- Nanoproducts		
UNIT-5	**7**	**12**
Industrial Applications of Nanomaterials: Nanoparticles and Micro –organism, Nano-materials in bone substitutes & Dentistry, Food and Cosmetic applications, Textiles, Paints, Catalysis, Drug delivery and its applications, Biochips- analytical devices, Biosensors.		
TOTAL	**36**	**60**

Text books:

1. "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" G. Cao, Imperial College Press, 2004.
2. Nanomaterials, Nanotechnologies and Design: An introduction for engineers and Architects, Micheal F. Ashby, P.J. Ferreria, D.L. Schodek,
3. Introduction to Nanoscience and Nanotechnology, Gabor .L et al,
4. Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009
5. Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, WILE-VCH, 2008

Course outcomes:

Students who have studied this course should

Learn about the background on Nanoscience.

Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.

Apply their learned knowledge to develop Nanomaterial's.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **ELECTROCHEMICAL ENERGY STORAGE SYSTEMS**		Course Code	: SC 827
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

To study details of various energy storage systems along with applications.

Enabling to identify the optimal solutions to a particular energy storage application/utility.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
LEAD ACID BATTERY: Advantages and disadvantages of lead acid batteries – Electrochemical reactions - Physical and chemical properties of active materials - Characteristics and properties of sulphuric acid - Constructional features - Materials and manufacturing methods - SLI (Automotive) batteries – Charge and discharge properties ties of lead acid batteries - Sealed lead acid or maintenance free batteries fabrication technology and testing - Lead acid battery for PV and automotive applications.		
UNIT-2	**7**	**12**
LITHIUM-ION BATTERY: Advanced anodes and cathodes – Theoretical capacity – Merits and demerits - Nanomaterials for anodes - Carbon nanotubes - SnO_2 – NiO - TiO_2& $LiTiO_4$, - Battery fabrication technology and testing - Batteries for electric vehicles - Hybrid vehicles and solar photovoltaic applications, All-solid-state battery.		
UNIT-3	**7**	**12**
METAL-AIR BATTERY: Lithium-Air - Sodium-Air – Zinc - Air batteries - Principle – Components – anodes – Cathodes - Fabrication – Evaluation – Merits - Demerits and Applications.		
UNIT-4	**8**	**12**
FUEL CELLS: Membrane electrode assemblies – Fabrication - Catalyst layer - Fuel cell supports – GDL - Bipolar plates - Fuel cell catalysts – Precious and nonprecious metal catalysts - Bi-functional catalysts – Nanomaterials for low temperature fuel cells – Reversible fuel cells - Fuel cell stacks and systems - Fuel cells for vehicles and grid connected applications.		
UNIT-5	**7**	**12**
HYBRID ENERGY SYSTEMS: Concept of hybrid energy systems - Supercapacitors – Fundamentals and types - Battery/supercapacitors hybrid systems – Example – Applications - Hybrid fuel cell/battery systems – Example – Applications.		
TOTAL	**36**	**60**

Text books:

1. Optoelectronics – An Introduction to materials and devices; Jasprit Singh, McGraw-Hill, 1996.
2. Materials for Optoelectronics; Maurice Quillec, Springer Science, 1996.
3. Optoelectronic Devices and Systems; S. C. Gupta, Prentice Hall India, 2005.

4. Optoelectronics - An introduction; J. Wilson and J. Hawkes, Prentice-Hall India, 1996.
5. Semiconductor optoelectronic devices; P. Bhattacharya, Prentice Hall India, 2006.
6. https://nptel.ac.in/courses/115/102/115102103/

Course outcomes:

Students who have studied this course should

Understand need of energy storage systems.
Acquire knowledge pertaining to various ways to store energy, its analysis and use.
Focus and develop hydrogen storage and fuel cell systems though research.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **RENEWABLE ENERGY**		Course Code	: SC 829
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

This course enables to understand various conventional and non-conventional energy resources.
To provide basic concept related to thermodynamics, fluid machines, heat transfer and electrical machine.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
SOLAR ENERGY: Basic concepts, solar radiation, potential of solar energy- environmental aspects of solar energy, technologies overview - Photon-to-electric energy conversion, photon-to-thermal-to-electric energy conversion, photon-to chemical energy conversion, semiconductors, solar cells, batteries, satellite solar power systems.		
UNIT-2	**7**	**12**
BIOMASS ENERGY: Concepts and systems, biomass production, energy plantations, short rotation species, forestry system, biomass resource agro forestry wastes, municipal solid wastes and agro processing industrial residues, environmental factors and biomass energy development, combustion, pyrolysis, gasification and liquefaction, modeling, appliances and latest development.BIOGAS CONVERSION ENERGY: Bioconversion: biogas, fermentation and wet processes, chemicals from biomass and biotechnology. Biodiesel, ethanol, methanol, manufacture properties and uses.		
UNIT-3	**7**	**12**
WIND ENERGY: Energy and power in wind - wind turbines - power and energy from wind turbines - commercial development and wind energy potential - economics -cost calculation – capital cost. Wave Energy - wave motion - power from wave energy. GEOTHERMAL AND WAVE ENERGY: Geothermal energy, types, systems and applications, ocean thermal energy, systems and applications. Wave energy systems and applications. Tidal energy - systems and applications.		
UNIT-4	**8**	**12**
HYDROELECTRICITY: Stored potential energy - power head and flow rate - world resource - types of hydroelectric plants - low, medium and high heads - estimation of power - economics of hydroelectric projects. Tidal Power -Nature of resource - basic physics - power generation -economical and environmental factors. Ocean Thermal Energy Conversion (OTEC) Introduction – OTEC power generation.		
UNIT-5	**7**	**12**
HYDROGEN ENERGY & FUEL CELLS: Design and principle of operation of a Fuel Cell (H_2, O_2 cell), Classification of Fuel Cells, Types of Fuel Cells, Advantages and Disadvantages of Fuel Cells, Conversion efficiency of Fuel Cells, Work output and EMF of Fuel Cells, Applications of Fuel Cells-Hydrogen Energy, Hydrogen production (Electrolysis method, Thermo-chemical methods, Fossil fuel methods, solar energy methods), Hydrogen storage,		

Hydrogen transportation, Utilization of Hydrogen Gas, Safety and management, Hydrogen technology development.		
TOTAL	**36**	**60**

Text books:

1. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme,2nd Ed. TMH
2. Solar energy, H. P. Garg and J Prakashi, TMH 1997
3. Renewable Energy Source and Conversion Technology, N.K Bansal, M. Kleemanm & M. Melss, TMH.
4. Renewable Energy, Godfrey Boyle, Oxford Univ. Press, 1996

Course outcomes:

Students who have studied this course should

Apply energy conversion device principle and evaluate their operation and performance.

Identify the working principle of different resources of energy.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSESSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	
INDIRECT ASSESSMENT	Student feedback		Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey			End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **VACUUM SCIENCE AND THIN FILM TECHNOLOGY**		Course Code	: SC 831
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

The course covers the importance of thin film technology and nanofabrication, vacuum technology. Various physical and chemical methods of thin film a fabrication and various applications of thin films including sensors.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Vacuum Science: Kinetic theory of gases: Atomistic concept of gas pressure and temperature, Molecular distribution functions, Impingement rate of molecules on a surface, Free path of gas molecules, Gas viscosity and flow, gas conductance of a vacuum line, gas impedance of a vacuum line, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes		
UNIT-2	**7**	**12**
Production of Vacuum: Meaning of vacuum and vacuum measuring units, vacuum ranges, pumping speed and pump down time. Vacuum Pumps: Mechanical pumps (Oil sealed rotary pump, Roots Pump, Molecular drag pump), Diffusion pump (Operating principles, back streaming, traps and baffles, performance ranges), Cryosorption pumps, Getter pumps (Chemical cleanup and sublimation pumps, Electrical cleanup and ion pumps, Evapour ion pumps, Sputter ion pumps, Titanium sublimation pump.		
UNIT-3	**7**	**12**
Vacuum Measurements: Measurement of low pressure Pressure gauges for low to high vacuum, Mc Leod manometer, Thermal conductivity gauges, Pressure gauges for high to ultrahigh vacuum, Hot cathode ionization gauges, Cold cathode ionization gauges, Operation of High-vacuum gauges. Vacuum Applications: Applications in science, technology, research, space science, medical science, day to day life. Use of vacuum in particle accelerators.		
UNIT-4	**8**	**12**
Thin Film technology: Nucleation and Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories: Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure; Structural defects and their incorporation. Properties of thin films: Electrical, mechanical, optical and magnetic.		
UNIT-5	**7**	**12**
Preparation methods: Electrochemical Deposition (ECD); Spin coating; Physical Vapor Deposition (PVD)- thermal evaporation, electron beam evaporation, rf-sputtering; Pulsed Laser deposition (PLD); Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD (PECVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE).		

Thickness measurement and monitoring: Electrical, mechanical, optical interference, microbalance, quartz crystal methods		
TOTAL	**36**	**60**

Text books:

1. Handbook of Thin Film Technology, L. I. Maissel and R. Glang, Mc Graw Hill Book Co. 1970, 07-039742-2
2. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.
3. Vacuum Technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
4. High Vacuum Techniques, J. Yarwood, (Chapman and Hall, London, 1967
5. Thin film Phenomena, by K.L. Chopra, Mcgraw-Hill Book Company

Course outcomes:

Students who have studied this course should

Vacuum technology and principle of vacuum pumps- various types and ranges will be covered.
Various fabrication methods of thin films will be dealt in detail.
Advantages, applications of thin films for devices also will be discussed.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	S	M
2	S	S	S	S	S	M
3	S	S	S	M	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	

INDIRECT ASSESSMENT	Student feedback	Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey		End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

Course Title: **INTELLECTUAL PROPERTY RIGHTS IPR**		Course Code	: SC 814
Semester	: **III**	Core / Elective	: **Core**
Teaching Scheme in Hrs (L:T:P)	**: 3:1:0**	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **36**
Continuous Internal Evaluation	: **40 Marks**	SEE	: **60 Marks**
Programmes: **M.Sc. (Physics)**			

Pre-requisites:

All students are expected to have a general knowledge of mathematical methods in physics.

Course Objectives:

The course has three major objectives.

To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.
To disseminate knowledge on copyrights, trademarks and registration aspects.
To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects.
To aware about current trends in IPR and Govt. steps in fostering IPR.

Course Content:

Topic and Contents	Hours	Marks
UNIT-1	**7**	**12**
Introduction and the need for intellectual property right (IPR) – Kinds of Intellectual Property Rights; International Conventions including TRIPS Agreement WIPO, UCC, Paris Union, Berne Convention, UNESCO. Patents :- Introduction & concepts, Historical Overview; Subject matter of patent; Kinds of Patents; Development of Law of Patents through international treaties and conventions including TRIPS Agreement; Procedure for grant of patents & term of Patent; Surrender, revocation and restoration of patent; Rights and obligations of Patentee; Grant of compulsory licenses; Infringement of Patent and legal remedies; Offences and penalties; Discussion on leading cases.		
UNIT-2	**7**	**12**
Meaning of Copyright, Historical Evolution; Subject matter of copyright; Literary works; Dramatic Works & Musical Works; Computer Programme; Cinematographic films; Registration of Copyrights; Term of Copyright and Ownership of Copyrights; Neighboring Rights; Rights of Performers & Broadcasters; Assignment of Copyright; Author's Special Rights (Moral Rights); Infringement of Copyrights and defenses; Remedies against infringement (Jurisdiction of Courts and penalties);		
UNIT-3	**7**	**12**
Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.		
UNIT-4	**8**	**12**
Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection.Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. Plant variety protection: meaning and benefit sharing and farmers'rights – Procedure		

for registration, effect of registration and term of protection. Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection		
UNIT-5	**7**	**12**
India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.		
TOTAL	**36**	**60**

Text books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis

Course outcomes:

Students who have studied this course should

The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works.

During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations.

Mapping Course Outcomes with Program Outcomes:

Course outcomes	Programme Outcomes					
	1	2	3	4	5	6
1	S	S	S	S	M	M
2	S	S	S	S	S	M

S: Strong relationship M: Moderate relationship

Course Assessment and Evaluation:

The Course will be delivered through lectures, class room interaction, exercises and self-study cases.

Method	What		To whom	When/where (Frequency in the course)	Max Marks	Evidence collected	Contributing to course outcomes
DIRECT ASSMENT	CIE	Mid Term Test	Student	Two tests	20	Midterm Answer books	
		Weekly Test		Two Weekly Test	10	Weekly Test Copies	
		Graded Assignments		Two Assignments	10	Log of record	
				Total	**40**		
	ESE	End Sem Evaluation		End of the course	60	Answer scripts at BTE	

INDIRECT ASSESSMENT	Student feedback	Students	Middle of the course	-NA-	Feedback forms	
	End of Course survey		End of course		Questionnaire	

CIE – Continuous Internal Evaluation **ESE** –End Semester Examination

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering and Understanding	35
2	Applying the knowledge acquired from the course	25
3	Analysis and Evaluation	40

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

SYLLABUS

M. Sc. BIOTECHNOLOGY
SCHOOL OF APPLIED SCIENCES

EDITION 2021-23

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences **Program: M.Sc. Biotechnology: Semester: I**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
1.	PC-501	Proficiency in Co-Curricular Activity	University Core	2	0	0	0		100	
2.	SC 501	Biochemistry	Program Core	3	3	0	0	3	40	60
3.	SC 503	Immunology and Immunotechnology	Program Core	3	3	0	0	3	40	60
4.	SC 505	Cell and Molecular Biology	Program Core	3	3	0	0	3	40	60
5.	SC 507	Bioanalytical Techniques	Program Core	3	3	0	0	3	40	60
6.	SC 551	Cell and Molecular Biology Lab	Program Core	2	0	0	3	3	60	40
7.	SC 553	Biochemistry Lab	Program Core	2	0	0	3	3	60	40
8.	SC 555	Immunology and Immunotechnology Lab	Program Core	2	0	0	3	3	60	40
9.	SC 557	Bioanalytical Tech Lab	Program Core	2	0	0	3	3	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences Program: M.Sc. Biotechnology: Semester: II

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-502	Employability Skills I	University Core	1	1	0	0	3	60	40
2.	PC-502	Proficiency in Co-Curricular Activity	University Core	2	0	0	0	0	100	
3.	SC 502	Genetic Engineering and Application	Program Core	3	3	0	0	3	40	60
4.	SC504	Genetics and Microbiology	Program Core	3	3	0	-	3	40	60
5.	SC 506	Bioinformatics	Program Core	3	3	0	-	3	40	60
6.	SC 508	Research Methodology and Scientific communication Skills	Program Core	2	0	0	2	3	60	40
7.		Elective I	Program Core	3	3	0	-	3	40	60
8.	SC 552	Genetic Engineering and Application Lab	Program Core	2	0	0	3	3	60	40
9.	SC 554	Genetics and Microbiology Lab	Program Core	2	0	0	3	3	60	40
10.	SC 556	Bioinformatics Lab	Program Core	2	0	0	3	3	60	40
11.	SM 558	Seminar – I	Program Core	1	1	0		0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective Subject:-

1. Nanobiotechnology (SC604)
2. Drug Designing and Development (SC610)
3. Antivirals and Vaccine Development (SC614)
4. Molecular Diagnostics (SC618)
5. Bio-entrepreneurship and Bio-business management (SC626)
6. Emerging Technologies (SC628)

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme
To commence from the Academic year: 2021-23

School of Applied Sciences **Program: M.Sc. Biotechnology: Semester: III**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-601	Employability Skills II	University Core	1	1	0	0	3	60	40
2.	PC-601	Proficiency in Co- Curricular Activity	University Core	2	0	0	0		100	
3.	SC 601	Bioprocess Engineering	Program Core	3	3	0	0	3	40	60
4.	SC 603	Plant and Animal Biotechnology	Program Core	3	3	0	0	3	40	60
5.	SC 605	Biostatistics	Program Core	3	3	0	0	3	40	60
6.	SC 607	Intellectual Property Rights, Biosafety and Bioethics	Program Core	3	3	0	0	3	40	60
7.		Elective II	Program Core	3	3	0	-	3	40	60
8.	SC 609	Project Proposal Preparation and Presentation	Program Core	2	0	0	3	3	60	40
9.	SC 611	Critical Analysis of Classical Papers	Program Core	2	0	0	3	3	60	40
10.	SC 651	Bioprocess Engineering Lab	Program Core	2	-	0	3	3	60	40
11.	SC 653	Plant and Animal Biotechnology lab	Program Core	2	-	0	0	3	60	40

12.	SC 655	Industrial Summer Project	Program Core	4	0	0	0		60	40
13.	SC 657	Seminar-II	Program Core	1	-	0	0	0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective Subject:-

1. Pharmaceutical Biotechnology (SC608)
2. Advanced Clinical Biochemistry (SC612)
3. Food and Dairy Technology (SC616)
4. Genomics & Proteomics (SC620)
5. Plant and Animal Tissue Culture (SC622)
6. Environmental Biotechnology (SC624)

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences **Program: M.Sc. Biotechnology: Semester: IV**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1	SC 602	Dissertation/ Project work	Program Core	20				2		100

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SC 501	BIOCHEMISTRY
Version	III
Prerequisite	All students are expected to have a general knowledge of biomolecules and its chemistry.
Learning 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. •
Expected Outcome	On completion of this course, students should be able to: • Gain fundamental knowledge in biochemistry; • Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.
Unit - I	**Chemical basis of life**
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.	
Unit - II	**Carbohydrate**
Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	
Unit - III	**Protein structure and enzyme kinetics**
Amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification. 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; concept of catalytic antibodies.	
Unit-IV	**Structure and function of DNA, RNA and Lipids**
Self-assembly of lipids, micelle, biomembrane 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.	
Unit-V	**Role of vitamins & cofactors in metabolism**
Vitamins and their role in daily life. 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 pathway.	
Reference books	1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. 2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth. 3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons. 4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. 5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63.

Mod of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 503	IMMUNOLOGY AND IMMUNOTECHNOLOGY
Version	III
Prerequisite	All students are expected to have knowledge of immune system and viruses.
Learning objective	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.
Expected Outcome	On completion of this course,students should be able to: • Evaluate 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).
Unit-I	**Immunology: fundamental concepts and overview of the immune system**
Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.	
Unit- II	**Immune responses generated by B and T lymphocytes**
Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.	
Unit-III	**Antigen-antibody interactions**
Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.	
Unit-IV	**Vaccinology**
Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.	
Unit-V	**Clinical immunology**

Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immune deficiencies, acquired or secondary immune deficiencies, autoimmune disorder, anaphylactic shock, immune senescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	
Reference books	1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman. 2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub. 3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science. 4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press. 5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press. 6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 505	**CELL AND MOLECULAR BIOLOGY 3**
Version	III
Prerequisite	All students are expected to have a basic knowledge of cell and it organelles.
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. ● To create an understanding about cause of cancer and the mechanism involve in cancer regulation. .
Expected Outcome	Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?
Unit-I	**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: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	
Unit- II	**Cell division and cell cycle**
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 signaling; cell motility and migration; cell death: different modes of cell death and their regulation.	
Unit-III	**Cellular signaling, 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.	
Unit-IV	**Chromatin structure and dynamics**
Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin- Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs).	
Unit-V	**Genome instability and cell transformation**
Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, 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.	
Reference 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. 2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman. 3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning. 4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings. 6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC507	**Bioanalytical techniques**
Version	I
Prerequisite	All students are expected to have a basic knowledge of tools and techniques used in life sciences.
Learning objective	The learning objective of course are: ● To create an understanding regarding the technical applications of various tools which are being used in life sciences. ● To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
Expected Outcome	The student will be able to conceptualize about tools and technique used in life sciences and Able to understand instrumentation in life science.
Unit-I	**Principles and applications of Microscopy**

Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.	
Unit- II	Spectrophotometry
Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology.	
Unit-III	Chromatographic Techniques
Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.	
Unit-IV	Electrophoresis
Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Isoelectric focusing. Isotachophoresis. 2-D Electrophoresis, Capillary electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis, Immunostaining and DNA finger printing and ELISA.	
Unit-V	**Radio tracer technique**
Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non-radiolabelling.	
Reference Books	1. Nuclear Magnetic Resonance: Williams 2. Biochemical Techniques theory and practice: White R 3. Analytical Chemistry: Christion G. D. 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H. 5. An Introduction to Practical Biochemistry: Plummer D. T. 6. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982 7. Tools in Biochemistry David Cooper 8. Methods of Protein and Nucleic acid Research, Osterman Vol I – III 9. Centrifugation D. Rickwood 10. Practical Biochemistry, Vth edition, Keth, Wilson and Walker.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

SC 502	**GENETIC ENGINEERING AND APPLICATION**
Version	III
Prerequisite	All students are expected to have a general and basic knowledge of molecular biology and Genetics.

Learning Objective	The learning objectives of course are: to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.
Expected Outcome	Given the impact of genetic engineering in modern society, the students shouldbe endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit-I	**Introduction to tools for genetic engineering**

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

Unit- II	**Vectors in genetic engineering**

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

Unit-III	**PCR techniques**

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products;T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

Unit-IV	**Gene manipulation and protein DNA interaction**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Unit-V	**Gene silencing and genome editing technologies**

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies gene targeting; creation of transgenic and knock-out mice; disease model;

Reference books

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 504	**GENETICS AND MICROBIOLOGY**
Version	III
Prerequisite	All students are expected to have a general knowledge of molecular biology and some basic concept of Genetics.
Learning objective	The learning objective of 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.
Expected Outcome	The student will be able to conceptualize about: • 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.
Unit-I	**Plant genetics**
Introduction: Historical developments in the field of genetics. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.	
Unit- II	**Genetics of bacteria, bacteriophages and Yeast**
Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene. 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.	
Unit-III	**Microbial Characteristics**
Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.	
Unit- IV	**Microbial Diversity**

Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes. Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.

Unit-V	**Control of microorganisms**

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms. Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Reference books	1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett. 2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman. 3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown. 4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 506	**BIOINFORMATICS**
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course are to provide theory and practical experience of theuse of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
Expected Outcome	The student will be able to conceptualize about ● 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.
Unit-I	**Introduction to Bioinformatics**

Bioinformatics basics: Computers in biology and medicine; Introduction to Unixand Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; 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.

Unit- II	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; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.	
Unit-III	**Multiple sequence analysis**
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: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.	
Unit-IV	**Protein modelling**
Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; 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.	
Unit-V	**Protein structure prediction and virtual library**
Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure prediction on a mystery sequence; 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; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design; Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.	
Reference books	1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press. 2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience. 4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture and Function*
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 601	BIOPROCESS ENGINEERING
Version	III

Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.
Learning 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 biotechnology industry. .
Expected Outcome	The student will be able to conceptualize about Appreciate relevance of microorganisms from industrial context;• Carry out stoichiometric calculations and specify models of their growth; • Give an account of design and operations of various fermenters;• Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products; • Calculate yield and production rates in a biological production process, and also interpret data; • Calculate the need for oxygen and oxygen transfer; • Critically analyze any bioprocess from market point of view; • Give an account of important microbial/enzymatic industrial processes in food and fuel industry.
Unit-I	**Basic principle 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.	
Unit- II	**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.	
Unit-III	**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.	
Unit-IV	**Application 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.	
Unit-V	**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	
Reference books	1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts.* Upper Saddle River, NJ: Prentice Hall. 2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press. 3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker. 4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill. 5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 603	**PLANT AND ANIMAL BIOTECHNOLOGY**
Version	II
Prerequisite	All students are expected to have a general knowledge of Plant and Animal Biotechnology.
Learning objective	The learning objective of course are: To create an understanding regarding the Plant tissue culture, production of haploid plants, Gene transfer in plant, animal biotechnology and gene regulation in Plants.
Expected Outcome	The student will be able to conceptualize about ● Nutritional requirements, micropropagation, agar culture and suspension culture in Plants ● Transgenic plants and their application ● Advantages and Disadvantages of Animal Biotechnology
Unit-I	**Introduction to Plant tissue culture**
Introduction to Plant tissue culture, Totipotency; Initiation and maintenance of callus and suspension culture. Single cell culture. Organogenesis; Shoot-tip culture: rapid clonal propagation and production of virus-free plants. Nutritional requirements, micropropagation, agar culture and suspension culture	
Unit- II	**Production of haploid plants**
Production of haploid plants through anther and ovary culture. Somatic embryogenesis. Embryo culture and embryo rescue.Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Cryo-preservation, Germplasm conservation.	
Unit-III	**Gene transfer in plant**
Gene transfer in plant; Physical and Chemical methods. Agrobacterium and Ti plasmids, Binary vectors. Plant viruses as vectors. Transgenic plants - application, methods of engineering insecticide and herbicide resistant plants. Anti-sense RNA technology - altering nutritional contents of plant foods.	
Unit-IV	**Introduction to animal biotechnology**
Introduction to animal biotechnology. Equipments and required materials for animal cell culture technology. Characteristics of cells in culture; Growth and maintenance of cells in culture; Cells and Cell lines, Culture media: Natural and Chemical Defined Media; Advantages and Disadvantages of Serum and Protein based media. Isolation and Disaggregation of tissues by Mechanical and Enzymatic Methods. Primary and established cell line cultures. Monoclonal antibodies. Immuno toxins as therapeutic agents Stem cell culture, embryonic stem cells and their applications.	
Unit-V	**Plant Gene Regulation**

Photoregulation and phytochrome regulation of nuclear and chloroplast genes expression, Molecular biology of light and dark reactions of photosynthesis, genetics of nif gene	
Reference books	1. Plant Biochemistry by Devlin. 2. Introduction of plant tissue culture : Rajdan and Bhojwani 3. Principles of gene manipuulation, Old,R.W. and Primrose,S.B., Blackwell Scientific Publishers, Fifth Edition, 1995. 4. .Plant Biochemistry and Molecular Biology – Hans, Walter and Heldt, Oxford UniversityPress, 1997. 5. Plant Biotechnology –Adrian Slater, Nigel Scot and Mark Fowler,Oxford University Press,2003. 6. Animal Biotechnology-Frashney
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 605	**BIOSTATISTICS**
Version	III
Prerequisite	All students are expected to have a general knowledge of Mathematics.
Learning objective	The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.
Expected Outcome	The student will be able to conceptualize about ● Scope of Biostatistics ● Correlation and regression ● Bioinformatics and Databases ● Sequence Analysis
Unit-I	**Definitions Scope of biostatistics**
Definitions Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data–Graphical and diagrammatic representation–scale diagrams–histograms–frequency polygan– Frequency curves. Measures of central tendency–arithmetic mean, median and mode–calculation of mean, median & mode in series of individual observations, discrete series continuous open – end classes.	
Unit I	**Correlation**
Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions Bivariate Data: Scatter diagram. Correlation and regression Simple correlation – correlation coefficient. Regression-simple, linear regression. Correlation coefficient and its properties, Correlation ratio. Rank – Spearman's and Kendall's measures of correlation.	
Unit- II	**Regression**

Principle of least squares, linear regression, fitting of curves reducible to polynomials by transformation. Multiple regression, Multiple and partial correlation coefficients. Basic ideas of significance test–Hypothesis testing level of significance–Test based on student 't' *'chi'* square and goodness of fit. 'F' test - ANOVA.	
Unit-V	**Probability and hypothesis testing**
Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.	
Unit-V	**Population Statistics**
Concepts of population and sample, advantages of sampling, census and sample surveys, Basic concepts in sampling and designing of a large scale surveys. Types of sample – the convenience sample, Judgment sample and the probability sample; simple random sampling with and without replacement. Unit II Systematic sampling, Stratified sampling, Estimation of mean, Proportion and standard error using the above probability sampling, probability proportional to size sampling, Estimation of sample size for clinical experiments, sources of error in surveys.	
Reference books	1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan. 2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science. 3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley. 4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press. 5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 607	**INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS**
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Stem cell.
Learning objective	The learning objective of course is: To create an understanding regarding the Stem cell biology, their types and Application.
Expected Outcome	The student will be able to conceptualize about : intellectual property rights, biosafety and bioethics
Unit-I	**Introduction to IPR**

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	
Unit- II	**Patenting**
Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting- introduction to existing schemes; publication of patents-gazette of India.	
Unit-III	**Biosafety**
Biosafety and Biosecurity - introduction; biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment;	
Unit-IV	**National and international regulations**
International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).	
Unit-V	**Bioethics**
Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	
Reference books	1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub. 2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI 3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct. 4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell. 5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press 7. World Trade Organisation. http://www.wto.org 8. World Intellectual Property Organisation. http://www.wipo.int 9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC604	**Nanobiotechnology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Introduction of nanobiotechnology** **08 hours**
Introduction, history and Timeline of Nanobiotechnology, Development of nanobiotechnology – timelines and progress, overview.	
UNIT-II	**Synthesis and Characterization of nanomaterials** **08 hours**
Nanomaterials for Biotechnolical Applications, Carbon Nanotubes, Nanowires, synthesiszing nanoparticles, Green synthesis of nanoparticles, characterization of nanoparticles.	
UNIT –III	**Nabobiotechnology detection system** **06 hours**
Varioustypes of transducing elements and their applications in Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticle as biosensors, DNA detection, small scale system for drug delivery.	
UNIT-IV	**Nanobiotechnology in chronic and infectious disease** **07 hours**
Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis and Therapy	
UNIT-V	**Nanobiotechnology in environment and food sciences** **07 hours**
Nanobiotechnology in environment, detection of food contaminants, food industry, Food preservation, waste water treatment.	
Text Book	*Bionanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation: (Percent Weight-age)	
Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

SC 620	GENOMICS AND PROTEOMICS
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.
Expected Outcome	The student will be able to conceptualize knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
Unit-I	**Basics of genomics and proteomics**
Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.	
Unit- II	**Genome mapping**
Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.	
Unit-III	**Genome sequencing project**
Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.	
Unit-IV	**Comparative genomics and proteomics**
Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence. Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.	
Unit-V	**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 function- forward and reverse genetics, gene ethics; protein- protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.	

Reference 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. 2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press. 3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC610	**Drug Designing and Development**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs
Learning objective	The learning objective of course are: To create an understanding regarding the Basics of Molecular Modelling and Drug Designing
Salient features	The student will be able to conceptualize basics to advance of Basics of Molecular Modelling and Drug Designing.
Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Biotechnological products** **8 hours**
	Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.
Unit-II	**Basic principles of molecular dynamics** **7 hours**
	Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.
Unit-III	**Vaccines** **7 hours**
	Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.
Unit-IV	**Drug Design** **7 hours**
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation
Unit-V	**Molecular Modelling** **7 hours**
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.
Reference books	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England, 1996. 2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000. 3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003. 4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego, 1996. 5. D. Frenkel and B. Smith, Understanding Molecular Simulations. From Algorithms to Applications, Academic Press, San Diego, California, 1996. 6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984. 7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, New York, 1986.

	8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids. Cambridge University Press, Cambridge, 1987. 9. D.C. Rapaport. The Art of Molecular Dynamics Simulation.Cambridge University Press, Cambridge, England., 1995
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 612	**ADVANCED CLINICAL BIOCHEMISTRY**
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	The learning objective of course are: To create an understanding regarding Blood, its function, neurotransmitters, neurohormones, composition function and regulation of body secretions, organ function test and Cancer.
Expected Outcome	The student will be able to conceptualize about ● Blood and its function ● Neurohormones and Neurotransmitter ● Organ function test ● Cancer
Unit-I	**Blood and its function, Synaptic transmission, Neurotransmitters & Neurohormones.**
Blood composition and its function. Blood-Pressure, Mechanism and regulation of blood coagulation. thalassemia. Haemorrhagic disorder –haemophilia, purpura, porphyries ,circulating anticoagulants. sickle cell anemia, Synaptic transmission, Neurotransmitters and Neurohormones , Biochemistry of vision.	
Unit- II	**Composition function and regulation of body secretions**
Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Structure of Nephron, Composition and formation of urine. Clinical significance of urinary components. homeostatic regulation of water and electrolytes .Acid -Base balance, -Acidosis and Alkalosis. Composition and biochemical analysis of CSF and amniotic fluid.	
Unit-III	**Organ function test**
Liver function test and related disorder: Jaundice, hepatitis, fatty liver and gall stone, Cirrhosis. Renal function test and related disorders, Gastric and pancreatic function test. Diagnostic test for lipoproteins disorders. Obesity – Definition, Genetic and environmental factors leading to obesity	
Unit-IV	**Enzyme: Clinical significance in health and diseases**
Clinical significance of enzymes in health and diseases. biochemical diagnosis of diseases by enzyme assays .SGOT, SGPT, CPK, alkalinephosphatase, cholinesterase and LDH. Inborn errors of metabolism: diabetes mellitus ,gaucher's disease, taysach's disease ,Niemann pick disease, phenylketonuria, alkaptonuria, albinism ,maple syrup disease,. Sexual Transmitted Disease	

Unit-V	Oncology
Oncology – Cancer markers for oral Cancer, Breast cancer and gastrointestinal tract cancer. Alpha feto proteins, Carcino embryonic antigens, Leukemia. Free radicals in diseases - Introduction, Types of free radicals, free radical induced lipid peroxidation. Scavengers – Superoxide dismutase, catalase, peroxidase and antioxidants	
Reference books	1.Clinical Biochemistry: An Illustrated Colour Text, 4e by Allan Gaw ,Michael J. Murphy (2008) 2.Marks' Basic Medical Biochemistry: A Clinical Approachby Michael A. Lieberman and Allan Marks (2008) 3.Textbook of Biochemistry with Clinical Correlations by Thomas M. Devlin .(2010) 4.Clinical Chemistry: Techniques, Principles, Correlations by Michael L. Bishop, Edward P. Fody and Larry E. Schoeff (2009) 5.Clinical Biochemistry (Fundamentals of Biomedical Science) by Nessar Ahmed (2011) 6.Essentials of Medical Biochemistry: With Clinical Cases by N. V. Bhagavan and Chung-Eun Ha (2011) 7.Medical Biochemistry at a Glance by J. G. Salway (2012)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC614	Antivirals and Vaccine development
Version	1.0
Prerequisite	All students are expected to have a general knowledge of basic microbiology.
Learning objective	The learning objective of course are: To create an understanding regarding the virology.
Salient features	The student will be able to conceptualize basics of virology and Designing and screening for antivirals.
Unit-I	**Conventional vaccines** **5 hours**
	Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues.
Unit-II	**Animal models** **4 hours**
	Animal models and vaccine potency testing.
Unit-III	**Immune markers** **5 hours**
	Vaccine induced immune response and immune markers of protection
Unit-IV	**Designing and screening for antivirals** **5 hours**
	Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance.

Unit-V	**Drug designing** **5 hours**
	Anti-sense RNA, siRNA, miRNA, ribozymes, in silico approaches for drug designing.
Reference books	1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker. 2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated. 3. Chimeric Virus -like Particles as Vacc ines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc. 4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC616	**Food and dairy Microbiology**
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Microbiology basic principles.
Learning objective	The learning objective of course are: To create an understanding regarding the life science, To gain knowledge about industrial food fermentations, Quality assurances in foods, foods preservation methods, fermentation of milk products and beverages and Advanced Food Microbiology.
Expected Outcome	The student will be able to conceptualize about ● Fermented vegetables, fermented Meat, Bakers Yeas ● Methods of food preservation ● Fermented milk product ● Applications of microbial enzymes in dairy industry
Unit-I	**Industrial Food fermentations**

Starter cultures their biochemical activities, production and preservation of the following fermented foods. a. Soy sauce fermentation by Moulds b. Fermented vegetables – Saurkraut c. Fermented Meat – Sausages d. Production and application of Bakers Yeast e. Application of microbial enzymes in food industry	
Unit- II	**Quality Assurances in foods**
Foodborne infections and intoxications; bacterial with examples of infective and toxic types –,Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.Mycotoxins in food with reference to Aspergillus species. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.	
Unit-III	**Food Preservation methods**
Radiations - UV, Gamma and microwave, Temperature Chemical and naturally occurring antimicrobials .Biosensors in food industry.	
Unit-IV	**Fermentation of Milk products and Beverages**
Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages – tea and coffee fermentations.Vinegar Fermentation	
Unit-V	**Advanced Food Microbiology**
Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases]. Utilization and disposal of dairy by-product – whey	
Reference books	1. Food Microbiology. 2nd Edition By Adams 2. Basic Food Microbiology by Banwart George J. 3. Food Microbiology: Fundamentals and Frontiers by Dolle 4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi. 5. Fundamentals of Dairy Microbiology by Prajapati. 6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition. 7. Dairy Microbiology by Robinson. Volume II and I.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 626 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Bio-entrepreneurship and Bio-business management**
Version	III
Prerequisite	All students are expected to have a general knowledge of Microbiology.
Learning objective	Research and business belong together and both are needed. In a rapidly developing life science industry, thereis an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach studentsabout concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.
Expected Outcome	The student will be able to conceptualize Students should be able to gain entrepreneurial skills, understandthe various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.
Unit-I	**Innovation and entrepreneurship in bio-business**
Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	
Unit- II	**Bio markets - business strategy and marketing**
Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	

Unit-III	**Finance and accounting**
Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	
Unit-IV	**Technology management**
Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP). .	
Reference Books	1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion. 2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge. 4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press. 5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC624	**Environmental Biotechnology**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Environmental Sciences.
Learning objective	The learning objective of course are: To create an understanding regarding the Environmental Biotechnology.
Salient features	The student will be able to conceptualize basics to advance of Environmental Biotechnology.
Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Conventional fuels and their environmental impact** **8 hours**
	Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol
Unit-II	**Bioremediation** **7 hours**
	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.
Unit-III	**Waste Treatment** **7 hours**
	Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)
Unit-IV	**Bioleaching** **7 hours**
	Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.
Unit-V	**Biodegradation** **7 hours**
	Overview of Biodegradation, Degradation of Basic Structures found in Hydrocarbons & Xenobiotics, Biodegradation of Xenobiotics, PCBs (Poly Chlorinated Biphenyls), DDT, Nitrobenzene, Biomagnifiction, Wastewater, Primary, Secondary, Tertiary treatment processes, Conventional Air Pollutants & Acid rain & Acid mine drainage, An overview of process of Bioremediation
Reference	1. Environmental Science, S.C. Santra

books	2. Environmental Biotechnology, Pradipta Kumar Mohapatra 3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter 4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill 5. Agricultural Biotechnology, S.S. Purohit 6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer 7. Introduction to Environmental Biotechnology, Milton Wainwright 8. Principles of Environmental Engineering, Gilbert Masters 9. Wastewater Engineering – Metcalf & Eddy
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC618	**MOLECULAR DIAGNOSTICS**
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer. ● .
Expected Outcome	Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
Unit-I	**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.	
Unit- II	**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.	

Unit-III	**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.	
Unit-IV	**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.	
Unit-V	**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.	
Reference books	1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press. 4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical* laboratorian Totowa, NJ: Humana Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 508	RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Version	II
Prerequisite	All students are expected to have a basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are togive background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics. about biotechnology, To have understanding about nature of damage, Able to analyse gene clonning management.
Expected Outcome	The student will be able to conceptualize : Understand 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.
Unit-I	**History of science and science methodologies**
Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology. .	
Unit- II	**Preparation for research**
Choosing a mentor, lab and research question; maintaining a lab notebook.	
Unit-III	**Process of communication**
Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences;	
Unit-IV	**Presentation skills**
Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.	
Unit-V	**Scientific communication**
Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	
Reference Books	1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press. 2. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press. 3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78 (Nov-Dec 1990), 550-558. 4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT

Recommended By BOS on:	
Approved by academic council on:	

SC 628	EMERGING TECHNOLOGIES
Version	II
Prerequisite	All students are expected to have a general knowledge of techniques applicable in biotechnology..
Learning objective	This course is broad-based in nature encompassing several new technologies that current researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.
Expected Outcome	The student will be able to conceptualize about : Theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.
Unit-I	**Optical microscopy method**
Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, signal-to- noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Stimulated Emission Depletion (STED).	
Unit- II	**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.	
Unit-III	**Systems biology**
High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.	
Unit-IV	**Structural biology AND CRISPR –CAS**
X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small- angle X-ray scattering, Atomic force microscopy. 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.	
Unit-V	**Nanobodies**
Introduction to nanobodies, 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.	
Reference books	1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev, J., & Theriot, J. (2009). P*hysical Biology of the Cell*. New York: Garland Science. 4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). *Biological Physics: Energy, Information, Life*. New York: W.H. Freeman. 5. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev. biochem.77.061906.092014. 6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems.* Science, 353(6299). doi:10.1126/science.aad5147. 7. Lander, E. (2016). *The Heroes of CRISPR.* Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041.

6. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344. doi:10.1038/535342a.

7. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). *A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity*. Science, 337(6096), 816-821. doi:10.1126/science.1225829.

10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers,

C., Songa, E. B., Hammers, R. (1993). *Naturally Occurring Antibodies Devoid of Light*

Chains. Nature, 363(6428), 446-448. doi:10.1038/363446a0.11. Sidhu, S. S., & Koide, S. (2007). *Phage Display for Engineering and Analyzing*

Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487.

doi:10.1016/j.sbi.2007.08.007.12. Steyaert, J., & Kobilka, B. K. (2011). *Nanobody Stabilization of G Protein-Coupled*

Receptor Conformational States. Current Opinion in Structural Biology,

	21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.13. Vincke, C., & Muyldermans, S. (2012). *Introduction to Heavy Chain Antibodies and* *Derived Nanobodies*. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779- 968-6_2.14. Verheesen, P., & Laeremans, T. (2012). *Selection by Phage Display of Single* *Domain Antibodies Specific to Antigens in their Native Conformation*. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). *Molecular Imprint* *of Enzyme Active Site by Camel Nanobodies*. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). *Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody.* Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.17. Chakravarty, R., Goel, S., & Cai, W. (2014). *Nanobody: The "Magic Bullet" for* *Molecular Imaging?* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 611	CRITICAL ANALYSIS OF CLASSICAL PAPERS
Version	III
Prerequisite	All students are expected to have a basic knowledge of biology and chemistry.
Learning objective	The objectives of this course are to familiarize students with classic literature to make them appreciate how ground- breaking discoveries were made without, necessarily, use of high-end technologies.
Expected Outcome	Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.
	How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed. A list of sixteen classic papers and some suggested reference materials:

Unit-I **MOLECULAR BIOLOGY (Any Four Paper)**

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58. **Note:** This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56. **Note:** Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8. **Note:** In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated.
4. Transposable mating type genes in *Saccharomyces cerevisiae* James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979 .**Note:** This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. 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:** The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology" .
6. *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 **Note:** This paper demonstrates that the telomerase contains the template for telomere synthesis

Unit- II **CELL BIOLOGY (Any Four)**

1. A protein-conducting channel in the endoplasmic reticulumSimon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80 **Note:** This paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis
2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15 **Note:** In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion.
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45 **Note:** Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16 **Note:** This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombination Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14 **Note:** This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognitionBuck L and Axel R; Cell. 1991 Apr 5;65(1):175-87 **Note:** This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.

Unit- III **Developmental biology and genetics**

1. Mutations affecting segment number and polarity in *Drosophila* Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980 **Note:** This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.
2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 **Note:** This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes.
3. Hedgehog signalling in the mouse requires intraflagellar transport proteins Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7 **Note:** One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway.
4. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it. Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT

Recommended By BOS on:	
Approved by academic council on:	

SC622	**Plant and Animal tissue culture**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Animal Cell and Tissue Culture** **08 hours**
Introduction of Animal Cell and Tissue Culture, History of development of Animal cell culture techniques, Significance and Applications of tissue culture techniques.	
UNIT-II	**Requirements in Animal Cell Culture**
Requirements in Animal Cell Culture, Equipments used in Cell culture, Culture vessels, Aseptic techniques, Culture media, designing of culture media, Serum free media development. Cell cycle analysis and	
UNIT –III	**Types of cell culture** **06 hours**
Primary culture, secondary culture, cell line, cryopreservation, contaminations, organotypic culture, Insect Cell Culture: An Overview, In vitro transformation of animal cells, Types of cell culture. Cell culture in vaccine production and drug/therapeutics development.	
UNIT-IV	**cancer studies using cell culture** **07 hours**
Synchronization of cultures, cancer studies using cell culture, production of hybridoma and monoclonal antibody production. Animal cloning, Therapeutic cloning, Tissue engineering, Knock out animals.	
UNIT-V	**plant tissue culture** **07 hours**
Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering. Introduction to animal cell and tissue culture and its applications, production of transgenic animals, cell transformation and cell lines, animal cloning.	
Text Book	*Bionanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation: (Percent Weight-age)	
Recommended by BOS on:	

Adopted by Faculty on:	
Approved by Academic Council on :	

SC 611	PROJECT PROPOSAL PREPARATION AND PRESENTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Plant and Animal Biotechnology.
Learning objective	The learning objective of course are: to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Expected Outcome	The student will be able to conceptualize about ● Formulate a scientific question; ● Present scientific approach to solve the problem; ● Interpret, discuss and communicate scientific results in written form; ● Gain experience in writing a scientific proposal; ● Learn how to present and explain their research findings to the audience effectively.
Unit-I	**Project proposal preparation**
Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.	
Unit- II	**Poster presentation**
Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.	
Unit-III	**Oral presentation**
At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 602	DISSERTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Microbiology and basic principles of Chemistry.
Learning objective	The learning objectives of 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.
Expected Outcome	The student will be able to conceptualize about 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: 1. In-depth knowledge of the chosen area of research. 2. Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis. 3. Competence in research design and planning. 4. Capability to create, analyse and critically evaluate different technical solutions. 5. Ability to conduct research independently. 6. Ability to perform analytical techniques/experimental methods. 7. Project management skills. 8. Report writing skills. 9. Problem solving skills. 10. Communication and interpersonal skills.
Unit-I	**Planning and performing experiments**
Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.	
Unit- II	**Thesis writing**
At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.	
Mode of Examination	student seminar/PPT
Recommended By BOS on:	

Approved by academic council on:	

SCHOOL OF APPLIED SCIENCES
M.Sc. Biotechnology
DETAILED SYLLABUS

SC602 DISSERTATION/ PROJECT WORK **C (L, T, P) = 14 (0, 0, 0)**

CLASS IV Sem M.Sc. Microbiology/Biotechnology	**EVALUATION**
Schedule Per Week Practicals:	Examination Time = Three (3) HoursMax. Marks =100 [Internal Assesment (60) & Semester End Exam (40)]

The Project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation of the work done. The dissertation submitted by the candidate shall be evaluated by one External expert ,Head of the Department and supervisor of the candidate. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under.

Max. Marks:- 100

Dissertation Record	60 marks
Viva Voce	40 marks
Total	100 marks

Scheme of Examination
General Guide-lines for Course of Study

1. The whole syllabus is divided into five units.
2. Number of teaching hours required to finish the contents of each unit are mentioned in the syllabus.
3. Books recommended/references are given at the end of each paper separately.
4. In P.G. programme list of periodicals for consultation are also given.
5. Two questions will be set from each unit and student will have to attempt one question from each unit.
6. Maximum time allowed for answering each question paper is 3 hours.
7. Maximum marks allotted to a paper are 70.

Examination Pattern

Evaluation will be done under two headings:

1. Theoretical Examination &Sessionals
2. Practical Examination & Sessional
3.

1. Theoretical Examination (100 Marks):

This will be further divided under two categories

(i) Internal Assessment	: 40 Marks	(40% Component)
(ii) End term Assessment	: 60 Marks	(60% Component)

(i) Internal Assessment (40 Marks): This is the 40% component of the total 100% theoretical examination & is further divided as follows

Process	Mid Term I	Mid Term II	Weekly Tests (1+1)	Assignment (1+1)	Total
Marks	10	10	05+05=10	05+05=10	40

Two Mid Term Examinations, Two Weekly Tests per subject and two assignments from each unit will be conducted for assessment as per the following schedule:

- After Completion of 1st Unit : Weekly test - I (to cover unit – I) and 2 assignments
- After Completion of 2nd Unit : Mid Term Exam-I and 2 assignments (to cover unit 1 & 2)
- After Completion of 3rd Unit : Weekly test – II (to cover unit 3) and 2 assignment
- After Completion of 4th Unit : Mid Term Exam – II & 2 assignments (to cover unit – 3 & 4)
- After Completion of 5th Unit : End Term Exams & 2 assignments (to covers all 5 units)

After completion of each unit, two assignments from each unit are to be given to the students, which will be submitted by the student after two working days. Thus total of 10 assignments will be assessed per semester. The Mid Term examination will be of 90 Min. duration and the concerned faculty members will be responsible for

the question papers & evaluation.
Mid Term marks will be displayed within two working days of exams.

(ii) End Term Assessment (70 Marks): End term examination will be of 3.00 hrs duration and the question paper and the evaluation system will be as follows

Question Paper: For paper setting each subject, paper should be sent to three paper setters randomly and then any one paper will be selected randomly.

Evaluation System: Final result will be declared within one month after completion of examination.

Centralized evaluation will be undertaken for End Term examinations.

2. Practical Examination &Sessionals (100 Marks):

The practical examination is also further divided into two categories i.e.

(i) Internal Assessment	: 60 Marks	(60% Component)
(ii) End Term Assessment	: 40 Marks	(40% Component)

(i) Internal Assessment (60 Marks): This is the 60% component of the total 100% practical examination and is further divided as follows

Process	Lab	Attendance	File work	Lab Project	Viva Voice	Total
Marks	10	10	10	20	10	60

- The internal exam component will be awarded on the basis of total number of experiments conducted during the practical classes.
- Marks of attendance will be awarded based on percentage of attendance. The students will be detained if the total percentage falls below 75% in all subjects taken together.
- The file work will depend on the submission of detailed theory & experimented record.
- Overall presentation on the practicals performed during the semester will be taken into consideration for award of marks.
- Internal viva on the practicals performed will form the basis for award of marks in Viva-Voce.

(iii) End Term Assessment (40 Marks): This examination will be final practical examination the evaluation of the final examination should be done on same day as given below:

(iv)

Process	Performance of the practical	Quiz	Viva voce	Total
Marks	15	15	10	40

Mid-Term exams, weekly test and assignment will be reflected in the academic calendar.

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

SYLLABUS

M. Sc. Microbiology

SCHOOL OF APPLIED SCIENCES

EDITION 2021-23

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

SCHOOL OF APPLIED SCIENCES
M.Sc. Microbiology

1. Need objectives and main features of curriculum

Curriculums of M.Sc. Microbiology are designed to provide Biochemist, Biotechnologist, Microbiologist and a good Researcher to the science world & society at large. It would not only provide an understanding but would also add on to their knowledge. The application of various tool and techniques in the field of Biochemistry/Biotechnology/Microbiology. The objective of designing this curriculum for the student is to update student's knowledge about:

1. Living system and their interaction with technology to generate things of mankind.
2. Encouraging students to develop intellectual independence, critical thinking skills and versatility.
3. Principles of various conventional and specialized laboratory investigations and instrumentation, analysis and interpretation of a given data; the ability to suggest experiments to support theoretical concepts and clinical diagnosis.
4. Molecular mechanisms of gene expression and regulation, the principles of genetic engineering and their application in medicine, agriculture, environment and food industries.
5. Biochemical and microbial basis of environmental health hazards and their remedial process and detoxication of xenobiotics
6. Inherited &disorders related to metabolism, microorganism, their pathology and possible cure
7. Molecular concepts of body defence and their application in medicine.
8 Infective micro-organisms of the human body and parasite interaction.
9. To acquire knowledge of antimicrobial agents for treatment of infection, scope of Immunotherapy and different vaccines available for prevention of communicable diseases
10. To be acquainted with methods of disinfection and sterilization to control and prevent hospital and community acquired infections
11. To conserve, map and sustainably use bioresources.
12. To disseminate general awareness for the optimum utilization of biotechnology in various sectors.
13. To optimally focus resources for R&D in biosciences.
14. To create centers of excellence as high quality support services to biotech industries.
15. To promote the field of bioinformatics.
16. To suitably address highly pertinent issues like intellectual property rights (IPR) protection, biosafety and bioethics.

2. Role of curriculum in national development

Bioscience has an important role to play in future social and economic well-being, on a national and international scale. It can lead to major following benefits:

1. Advances in agriculture and crop technology can help fight world starving population.
2. Innovations in food and nutritional science can lead to everyday improvements in health and hygiene.
3. Innovative technology can boost the leading role of Indian commerce specially food & dairy, pharmaceutical, agriculture and FMCG.
4. Producing things using biotechnology and contributing towards national economy and GDP

5. Designing new drugs with the help of r DNA technology for curing diseases.
6. Finding cure for various genetic disorders and adding health benefits to Indian society.

3. Global trends reflecting in the curriculum

The profession of scientist has pious mandatory duty to undertake research and develop new products using micro organisms, stem cell, restriction enzymes, genome etc. in various field of bioscience which attribute to human welfare ,directly or indirectly . The current science is rapidly advancing by the efforts of the biochemist, biotechnologist and microbiologist. Present course have been developed to educate the student not only about the advancement in the field of biosciences but also to give them exposure of these requisites.

4. Possibility, motivation and scope for self learning

Knowledge of Biosciences helps identity various areas where the application of r-DNA technology, genetic engineering, biochemical and microbiological technique could be utilized. The products like new drugs, vaccines, GMF, transgenic animal, transgenic plant, diseases diagnostic kits, biopesticides etc. could be generated in the benefit of mankind and society. This field need good level scientific input from scientists trained across various disciplines including analytical biochemistry, clinical biochemistry, molecular biology, genetic engineering, Nano-technology , bioprocess technology, microbiology etc.

5. Placement opportunities

A wide range of career opportunities are available for students of Bioscience. There are numerous opening available to choose from one they have attained education. Those include:
Agriculture, Agrochemical Companies, Clinical and Forensic Science Laboratories, Corporate Firms, Food /Beverages Industries, Hospitals, Pharmaceutical Industry, Research and Educational Institutions, Clinical Research, Management, Manufacturing, Marketing, Quality Control, Information
Science ,Technical Writing and Editing. Besides this students can also opt for teaching in the respective field.

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences Program: M.Sc. Microbiology: Semester: I

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
1.	PC-501	Proficiency in Co-Curricular Activity	University Core	2	0	0	0		100	
2.	SC 501	Biochemistry	Program Core	3	3	0	0	3	40	60
3.	SC 503	Immunology and Immunotechnology	Program Core	3	3	0	0	3	40	60
4.	SC 505	Cell and Molecular Biology	Program Core	3	3	0	0	3	40	60
5.	SC 507	Bioanalytical Techniques	Program Core	3	3	0	0	3	40	60
6.	SC 551	Cell and Molecular Biology Lab	Program Core	2	0	0	3	3	60	40
7.	SC 553	Biochemistry Lab	Program Core	2	0	0	3	3	60	40
8.	SC 555	Immunology and Immunotechnology Lab	Program Core	2	0	0	3	3	60	40
9.	SC557	Bioanalytical Tech Lab	Program Core	2	0	0	3	3	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences **Program: M.Sc. Microbiology: Semester: II**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-502	Employability Skills I	University Core	1	1	0	0	3	60	40
2.	PC-502	Proficiency in Co-Curricular Activity	University Core	2	0	0	0	0	100	
3.	SC 502	Genetic Engineering and Application	Program Core	3	3	0	0	3	40	60
4.	SC504	Genetics and Microbiology	Program Core	3	3	0	-	3	40	60
5.	SC 506	Bioinformatics	Program Core	3	3	0	-	3	40	60
6.	SC 508	Research Methodology and Scientific communication Skills	Program Core	2	0	0	2	3	60	40
7.		Elective I	Program Core	3	3	0	-	3	40	60
8.	SC 552	Genetic Engineering and Application Lab	Program Core	2	0	0	3	3	60	40
9.	SC 554	Genetics and Microbiology Lab	Program Core	2	0	0	3	3	60	40
10.	SC 556	Bioinformatics Lab	Program Core	2	0	0	3	3	60	40
11.	SM 558	Seminar - I	Program Core	1	1	0		0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS_____**

Signature of Member Secretary

Elective

1. Food and Dairy Technology (SC616)
2. Genomics & Proteomics (SC620)
3. Microbial Physiology and Metabolism (SC638)
4. Virology (SC640)
5. Bio-entrepreneurship and Bio-business management (SC626)
6. Microbial Pathogenicity (SC642)

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme
To commence from the Academic year: 21-23
School of Applied Sciences Program: M.Sc. Microbiology: Semester: III

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-601	Employability Skills II	University Core	1	1	0	0	3	60	40
2.	PC-601	Proficiency in Co- Curricular Activity	University Core	2	0	0	0		100	
3.	SC 601	Bioprocess Engineering	Program Core	3	3	0	0	3	40	60
4.	SC 613	Basic and Applied Epidemiology	Program Core	3	3	0	0	3	40	60
5.	SC 605	Biostatistics	Program Core	3	3	0	0	3	40	60
6.	SC 607	Intellectual Property Rights, Biosafety and Bioethics	Program Core	3	3	0	0	3	40	60
7.		Elective II	Program Core	3	3	0	-	3	40	60
8.	SC 609	Project Proposal Preparation and Presentation	Program Core	2	0	0	3	3	60	40
9.	SC 611	Critical Analysis of Classical Papers	Program Core	2	0	0	3	3	60	40

10.	SC 651	Bioprocess Engineering Lab	Program Core	2	-	0	3	3	60	40
11.	SC 659	Epidemiology lab	Program Core	2	-	0	0	3	60	40
12.	SC655	Industrial Summer Project	Program Core	4	0	0	0		60	40
13.	SC 657	Seminar-II	Program Core	1	-	0	0	0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective:

1. Nanobiotechnology (SC604)
2. Plant Pathogen Interaction (SC628)
3. Environmental Microbiology (SC630)
4. Drug Designing and Development (SC632)
5. Advanced Clinical Biochemistry (SC634)
6. Antivirals and Vaccine Development (SC636)

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23

School of Applied Sciences **Program: M.Sc. Microbiology: Semester: IV**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CE	ESE
1	SC 602	Dissertation/ Project work	20	0	0	0	3		100

L – Lecture
T – Tutorial
– Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SC 501	BIOCHEMISTRY
Version	III
Prerequisite	All students are expected to have a general knowledge of biomolecules and its chemistry.
Learning 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. •
Expected Outcome	On completion of this course, students should be able to: • Gain fundamental knowledge in biochemistry; • Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.
Unit-I	**Chemical basis of life**
Water – properties of water, essential roleof 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.	
Unit- II	**Carbohydrate**
Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	
Unit-III	**Protein structure and enzyme kinetics**
Amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification 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; concept of catalytic antibodies.	
Unit-IV	**Structure and function of DNA, RNA and Lipids**
Self-assembly of lipids, micelle, biomembrane 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.	
Unit-V	**Role of vitamins & cofactors in metabolism**
Vitamins and their role in daily life. 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 pathway.	
Reference books	1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. 2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth. 3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons. 4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. 5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT

Recommended By BOS on:	
Approved by academic council on:	

SC 503	IMMUNOLOGY AND IMMUNOTECHNOLOGY
Version	III
Prerequisite	All students are expected to have knowledge of immune system and viruses.
Learning objective	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.
Expected Outcome	On completion of this course, students should be able to: • Evaluate 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).
Unit-I	**Immunology: fundamental concepts and overview of the immune system**

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

Unit- II	**Immune responses generated by B and T lymphocytes**

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Unit-III	**Antigen-antibody interactions**

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit-IV	**Vaccinology**

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Unit-V	**Clinical immunology**

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immune deficiencies, acquired or secondary immune deficiencies, autoimmune disorder, anaphylactic shock, immune senescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	
Reference books	1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman. 2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub. 3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science. 4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press. 5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press. 6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 505	**CELL AND MOLECULAR BIOLOGY 3**
Version	III
Prerequisite	All students are expected to have a basic knowledge of cell and it organelles.
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. ● To create an understanding about cause of cancer and the mechanism involve in cancer regulation. .
Expected Outcome	Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?
Unit-I	**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: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	
Unit- II	**Cell division and cell cycle**
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 signaling; cell motility and migration; cell death: different modes of cell death and their regulation.	
Unit-III	**Cellular signaling, 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.	
Unit-IV	**Chromatin structure and dynamics**
Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs).	
Unit-V	**Genome instability and cell transformation**
Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, 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.	
Reference 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. 2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman. 3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning. 4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings. 6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC507	**Bioanalytical techniques**
Version	I
Prerequisite	All students are expected to have a basic knowledge of tools and techniques used in life sciences.
Learning objective	The learning objective of course are: ● To create an understanding regarding the technical applications of various tools which are being used in life sciences. ● To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.

Expected Outcome	The student will be able to conceptualize about tools and technique used in life sciences and Able to understand instrumentation in life science.
Unit-I	**Principles and applications of Microscopy**
Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.	
Unit- II	**Spectrophotometry**
Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology.	
Unit-III	**Chromatographic Techniques**
Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.	
Unit-IV	**Electrophoresis**
Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Isoelectric focusing. Isotachophoresis. 2-D Electrophoresis, Capillary electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis, Immunostaining and DNA finger printing and ELISA.	
Unit-V	**Radio tracer technique**
Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non-radiolabelling.	
Reference Books	1. Nuclear Magnetic Resonance: Williams 2. Biochemical Techniques theory and practice: White R 3. Analytical Chemistry: Christion G. D. 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H. 5. An Introduction to Practical Biochemistry: Plummer D. T. 6. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982 7. Tools in Biochemistry David Cooper 8. Methods of Protein and Nucleic acid Research, Osterman Vol I – III 9. Centrifugation D. Rickwood 10. Practical Biochemistry, Vth edition, Keth, Wilson and Walker.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	
SC 502	**GENETIC ENGINEERING AND APPLICATION**
Version	III
Prerequisite	All students are expected to have a general and basic knowledge of molecular biology and Genetics.
Learning Objective	The learning objectives of course are: to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.

Expected Outcome	Given the impact of genetic engineering in modern society, the students shouldbe endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.
Unit-I	**Introduction to tools for genetic engineering**
Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.	
Unit- II	**Vectors in genetic engineering**
Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	
Unit-III	**PCR techniques**
Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products;T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	
Unit-IV	**Gene manipulation and protein DNA interaction**
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
Unit-V	**Gene silencing and genome editing technologies**
Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies gene targeting; creation of transgenic and knock-out mice; disease model;	
Reference books	1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications. 2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science. 5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 504	GENETICS AND MICROBIOLOGY
Version	III
Prerequisite	All students are expected to have a general knowledge of molecular biology and some basic concept of Genetics.
Learning objective	The learning objective of 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.
Expected Outcome	The student will be able to conceptualize about: • 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.
Unit-I	**Plant genetics**
Introduction: Historical developments in the field of genetics. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.	
Unit- II	**Genetics of bacteria, bacteriophages and Yeast**
Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene. 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.	
Unit-III	**Microbial Characteristics**
Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.	
Unit- IV	**Microbial Diversity**
Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes. Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.	
Unit-V	**Control of microorganisms**

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms. Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.	
Reference books	1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett. 2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman. 3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown. 4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 506	**BIOINFORMATICS**
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course are to provide theory and practical experience of theuse of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
Expected Outcome	The student will be able to conceptualize about ● 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.
Unit-I	**Introduction to Bioinformatics**
Bioinformatics basics: Computers in biology and medicine; Introduction to Unixand Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; 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.	
Unit- II	**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; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.	
Unit-III	**Multiple sequence analysis**
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: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.	

Unit-IV	Protein modelling
Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; 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.	
Unit-V	**Protein structure prediction and virtual library**
Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure prediction on a mystery sequence; 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; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design; Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.	
Reference books	1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press. 2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience. 4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture and Function*
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 601	BIOPROCESS ENGINEERING
Version	III
Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.
Learning 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 biotechnology industry. .
Expected Outcome	The student will be able to conceptualize about Appreciate relevance of microorganisms from industrial context;• Carry out stoichiometric calculations and specify models of their growth; • Give an account of design and operations of various fermenters;• Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products; • Calculate yield and production rates in a biological production process, and also interpret data; • Calculate the need for oxygen and oxygen transfer; • Critically analyze any bioprocess from market point of view; • Give an account of important microbial/enzymatic industrial processes in food and fuel industry.
Unit-I	**Basic principle 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.	
Unit- II	**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.	
Unit-III	**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.	
Unit-IV	**Application 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.	
Unit-V	**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.	
Reference books	1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts.* Upper Saddle River, NJ: Prentice Hall. 2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press. 3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker. 4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill. 5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 605	BIOSTATISTICS
Version	III
Prerequisite	All students are expected to have a general knowledge of Mathematics.
Learning objective	The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.
Expected Outcome	The student will be able to conceptualize about ● Scope of Biostatistics ● Correlation and regression ● Bioinformatics and Databases ● Sequence Analysis
Unit-I	**Definitions Scope of biostatistics**
Definitions Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data–Graphical and diagrammatic representation–scale diagrams–histograms–frequency polygan– Frequency curves. Measures of central tendency–arithmetic mean, median and mode–calculation of mean, median & mode in series of individual observations, discrete series continuous open – end classes.	
Unit I	**Correlation**
Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions Bivariate Data: Scatter diagram. Correlation and regression Simple correlation – correlation coefficient. Regression-simple, linear regression. Correlation coefficient and its properties, Correlation ratio. Rank – Spearman's and Kendall's measures of correlation.	
Unit- II	**Regression**
Principle of least squares, linear regression, fitting of curves reducible to polynomials by transformation. Multiple regression, Multiple and partial correlation coefficients. Basic ideas of significance test–Hypothesis testing level of significance–Test based on student 't' *'chi'* square and goodness of fit. 'F' test - ANOVA.	
Unit-V	**Probability and hypothesis testing**
Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.	
Unit-V	**Population Statistics**
Concepts of population and sample, advantages of sampling, census and sample surveys, Basic concepts in sampling and designing of a large scale surveys. Types of sample – the convenience sample, Judgment sample and the probability sample; simple random sampling with and without replacement. Unit II Systematic sampling, Stratified sampling, Estimation of mean, Proportion and standard error using the above probability sampling, probability proportional to size sampling, Estimation of sample size for clinical experiments, sources of error in surveys.	
Reference books	1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan. 2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science. 3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley. 4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press. 5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended	

By BOS on:	
Approved by academic council on:	

SC613	**Basic and Applied epidemiology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Historical aspects**
Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology. Descriptive and analytical epidemiology, disease burden, natural history of diseases and measures of risk and death. Sample size estimation and introduction to study design in epidemiological investigations.	
UNIT-II	**Types and methods of public health 08 hours**
Types and methods of public health and infectious disease surveillance, establishing surveillance system.	
UNIT –III	**Case control and cohort studies.06 hours**
Case control and cohort studies.	
UNIT-IV	**Outbreak investigations** **07 hours**
Needs and steps to be taken for outbreak investigations, collaboration with State and National health authorities.	
UNIT-V	**Veterinary Epidemiology** **07 hours**
Veterinary Epidemiology	Veterinary Epidemiology
Text Book	*Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.*
Reference Books	1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press. 2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences. 3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press. 4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc. 5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004. 6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub. Date: April 2005. Publisher: SAGE Publications.
Mode of Evaluation:	

(Percent Weight-age)	
Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

SC 607	**INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS**
`Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Stem cell.
Learning objective	The learning objective of course is: To create an understanding regarding the Stem cell biology, their types and Application.
Expected Outcome	The student will be able to conceptualize about : intellectual property rights, biosafety and bioethics
Unit-I	**Introduction to IPR**
Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	
Unit- II	**Patenting**
Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India.	
Unit-III	**Biosafety**
Biosafety and Biosecurity - introduction; biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment;	
Unit-IV	**National and international regulations**
International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).	
Unit-V	**Bioethics**
Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy,	

transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	
Reference books	1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub. 2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI 3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct. 4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell. 5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press 7. World Trade Organisation. http://www.wto.org
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC604	**Nanobiotechnology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Introduction of nanobiotechnology** **08 hours**
Introduction, history and Timeline of Nanobiotechnology, Development of nanobiotechnology – timelines and progress, overview.	
UNIT-II	**Synthesis and Characterization of nanomaterials** **08 hours**
Nanomaterials for Biotechnolical Applications, Carbon Nanotubes, Nanowires, synthesiszing nanoparticles, Green synthesis of nanoparticles, characterization of nanoparticles.	
UNIT –III	**Nabobiotechnology detection system** **06 hours**
Varioustypes of transducing elements and their applications in Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticle as biosensors, DNA detection, small scale system for drug delivery.	
UNIT-IV	**Nanobiotechnology in chronic and infectious disease** **07 hours**
Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis and Therapy	
UNIT-V	**Nanobiotechnology in environment and food sciences** **07 hours**

Nanobiotechnology in environment, detection of food contaminants, food industry, Food preservation, waste water treatment.	
Text Book	*Bionanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation: (Percent Weight-age)	
Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

SM 628	PLANT PATHOGEN INTERACTION
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course is to provide introductory knowledge about plant diseases and their etiological studies and their applications.
Expected Outcome	The student will be able to conceptualize knowledge and understanding of fundamentals of Concepts and physiology of plant diseases and their applications in various applied areas of biology.
Unit-I	**Concepts and physiology of plant diseases**
What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation.	
Unit- II	**Plant diseases and their etiological studies**
Enzymes and toxins in plant diseases, phytoalexins. Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops.	
Unit-III	**Genetic basis of plant diseases and disease forecasting**
Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. History and important milestones in disease control, disease forecasting and its relevance in Indian farming.	
Unit-IV	**Disease control**
Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, Trichoderma as biocontrol agent, biocontrol agents – uses and practical constraints.	
Unit-V	**Molecular approach**
Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.	
Reference books	1. Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi. 2. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993. 3. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003. 4. The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT

Recommended By BOS on:	
Approved by academic council on:	

SM 630	**ENVIRONEMNATL MICROBIOLOGY**
Version	II
Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.
Learning objective	The objectives of this course are to educate students about the fundamental concepts of Basic principle of biochemical engineering and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry. .
Expected Outcome	The student will be able to conceptualize about Appreciate relevance of microorganisms from environmental context
Unit-I	**Basic principle 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.	
Unit- II	**Aerobiology**
Droplet nuclei, aerosol, assessment of air quality, - solid liquid impingment methods, Brief account of air borne transmission of microbes, viruses, bacteria and fungi, their diseases and preventive measures.	
Unit-III	**Aquatic microbiology**
Water ecosystems types: fresh water (ponds, lakes, streams) marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coralreefs). Zonation of water ecosystems, upwelling, eutrophication, food chain. Potability of water, microbial assessment of water quality, water purification, brief account of major water borne diseases and their control measures.	
Unit-IV	**Soil Microbiology**

Classification of soils, physical and chemical characteristics, microflora of various soil types (bacteria and nematodes in relevance to soil types;), a brief account of microbial interactions symbiosis, mutualism commensalisms, competition, amensalism, synergism, parasitism, predation; biogeochemical cycles and the organisms, carbon, nitrogen, phosphorous and sulphur, biofertilizers, biological nitrogen fixation, nitrogenase enzyme, nif genes; symbiotic nitrogen fixation (Rhizobium, Frankia), nonsymbiotic microbes, rumen microbiology.	
Unit-V	**Waste treatment**
Wastes types, solid and liquid wastes characterization, solid liquid; treatments physical, chemical, biological aerobic anaerobic primary secondary tertiary; solid waste treatment saccharification gasification composting, Utilization of solid wastes food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment trickling activated sludge oxidation pond oxidation ditch. Subterranean microbes and bioremediation. Bioaccumulation of metals and detoxification biopesticides; bio deterioration of paper leather, wood, textiles and metal corrosion.	
Reference books	1. Alexander, M: Microbial ecology, John Wiley and sons, Inc., New York. 2. Ec Eldowney., S. Hardman, D.J. and Waite, S: Pollution: Ecology and biotreatment Longman Scientific Technical. 3. K.C. Marshall: Advances in microbial ecology.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SCSC632	**Drug Designing and Development**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs
Learning objective	The learning objective of course are: To create an understanding regarding the Basics of Molecular Modelling and Drug Designing
Salient features	The student will be able to conceptualize basics to advance of Basics of Molecular Modelling and Drug Designing.
Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Biotechnological products** **8 hours**
	Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs,

	Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.
Unit-II	**Basic principles of molecular dynamics 7 hours**
	Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.
Unit-III	**Vaccines 7 hours**
	Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.
Unit-IV	**Drug Design 7 hours**
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation
Unit-V	**Molecular Modelling 7 hours**
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.
Reference books	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England, 1996. 2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000. 3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003. 4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego, 1996. 5. D. Frenkel and B. Smith, Understanding Molecular Simulations. From Algorithms to Applications, Academic Press, San Diego, California, 1996. 6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984. 7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, New York, 1986. 8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids. Cambridge University Press, Cambridge, 1987. 9. D.C. Rapaport. The Art of Molecular Dynamics Simulation.Cambridge University Press, Cambridge, England., 1995
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 634	**ADVANCED CLINICAL BIOCHEMISTRY**
Version	II
Prerequisite	All students are expected to have a basic concept of general biology , chemistry and biochemistry.
Learning objective	The learning objective of course are: To create an understanding regarding Blood, its function, neurotransmitters, neurohormones, composition function and regulation of body secretions, organ function test and Cancer.

Expected Outcome	The student will be able to conceptualize about ● Blood and its function ● Neurohormones and Neurotransmitter ● Organ function test ● Cancer
Unit-I	**Blood and its function, Synaptic transmission, Neurotransmitters & Neurohormones.**
Blood composition and its function. Blood-Pressure, Mechanism and regulation of blood coagulation. thalassemia. haemorrhagic disorder –haemophilia, purpura, porphyries ,circulating anticoagulants. sickle cell anemia, Synaptic transmission, Neurotransmitters and Neurohormones , Biochemistry of vision.	
Unit- II	**Composition function and regulation of body secretions**
Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Structure of Nephron, Composition and formation of urine. Clinical significance of urinary components. homeostatic regulation of water and electrolytes .Acid -Base balance, -Acidosis and Alkalosis. Composition and biochemical analysis of CSF and amniotic fluid.	
Unit-III	**Organ function test**
Liver function test and related disorder: Jaundice, hepatitis, fatty liver and gall stone, Cirrhosis. Renal function test and related disorders, Gastric and pancreatic function test. Diagnostic test for lipoproteins disorders. Obesity – Definition, Genetic and environmental factors leading to obesity	
Unit-IV	**Enzyme: Clinical significance in health and diseases**
Clinical significance of enzymes in health and diseases. biochemical diagnosis of diseases by enzyme assays .SGOT, SGPT, CPK, alkalinephosphatase, cholinesterase and LDH. Inborn errors of metabolism: diabetes mellitus ,gaucher's disease, taysach's disease ,Niemann pick disease, phenylketonuria, alkaptonuria, albinism ,maple syrup disease,. Sexual Transmitted Disease	
Unit-V	**Oncology**
Oncology – Cancer markers for oral Cancer, Breast cancer and gastrointestinal tract cancer. Alpha feto proteins, Carcino embryonic antigens, Leukemia. Free radicals in diseases - Introduction, Types of free radicals, free radical induced lipid peroxidation. Scavengers – Superoxide dismutase, catalase, peroxidase and antioxidants	
Reference books	1.Clinical Biochemistry: An Illustrated Colour Text, 4e by Allan Gaw ,Michael J. Murphy (2008) 2.Marks' Basic Medical Biochemistry: A Clinical Approachby Michael A. Lieberman and Allan Marks (2008) 3.Textbook of Biochemistry with Clinical Correlations by Thomas M. Devlin .(2010) 4.Clinical Chemistry: Techniques, Principles, Correlations by Michael L. Bishop, Edward P. Fody and Larry E. Schoeff (2009) 5.Clinical Biochemistry (Fundamentals of Biomedical Science) by Nessar Ahmed (2011) 6.Essentials of Medical Biochemistry: With Clinical Cases by N. V. Bhagavan and Chung-Eun Ha (2011) 7.Medical Biochemistry at a Glance by J. G. Salway (2012)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

MVI 636	**Antivirals and Vaccines**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of basic microbiology.
Learning objective	The learning objective of course are: To create an understanding regarding the virology.
Salient features	The student will be able to conceptualize basics of virology
Unit-I	**Conventional vaccines** **5 hours**
	Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues.
Unit-II	**Animal models** **4 hours**
	Animal models and vaccine potency testing.
Unit-III	**Immune markers** **5 hours**
	Vaccine induced immune response and immune markers of protection
Unit-IV	**Designing and screening for antivirals** **5 hours**
	Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance.
Unit-V	**Drug designing** **5 hours**
	Anti-sense RNA, siRNA, miRNA, ribozymes, in silico approaches for drug designing.
Reference books	1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker. 2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated. 3. Chimeric Virus -like Particles as Vacc ines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc. 4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC616	Food and dairy technology
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Microbiology basic principles.
Learning objective	The learning objective of course are: To create an understanding regarding the life science, To gain knowledge about industrial food fermentations, Quality assurances in foods, foods preservation methods, fermentation of milk products and beverages and Advanced Food Microbiology.
Expected Outcome	The student will be able to conceptualize about ● Fermented vegetables, fermented Meat, Bakers Yeas ● Methods of food preservation ● Fermented milk product ● Applications of microbial enzymes in dairy industry
Unit-I	**Industrial Food fermentations**
Starter cultures their biochemical activities, production and preservation of the following fermented foods. a. Soy sauce fermentation by Moulds b. Fermented vegetables – Saurkraut c. Fermented Meat – Sausages d. Production and application of Bakers Yeast e. Application of microbial enzymes in food industry	
Unit- II	**Quality Assurances in foods**
Foodborne infections and intoxications; bacterial with examples of infective and toxic types –,Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.Mycotoxins in food with reference to Aspergillus species. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.	
Unit-III	**Food Preservation methods**
Radiations - UV, Gamma and microwave, Temperature Chemical and naturally occurring antimicrobials .Biosensors in food industry.	
Unit-IV	**Fermentation of Milk products and Beverages**
Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages – tea and coffee fermentations.Vinegar Fermentation	
Unit-V	**Advanced Food Microbiology**
Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases]. Utilization and disposal of dairy by-product – whey	

Reference books	1. Food Microbiology. 2nd Edition By Adams 2. Basic Food Microbiology by Banwart George J. 3. Food Microbiology: Fundamentals and Frontiers by Dolle 4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi. 5. Fundamentals of Dairy Microbiology by Prajapati. 6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition. 7. Dairy Microbiology by Robinson. Volume II and I.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 626 MICROBIAL DIVERSITY AND PHYSIOLOGY	**Bio-entrepreneurship and Bio-business management**
Version	III
Prerequisite	All students are expected to have a general knowledge of Microbiology.

Learning objective	Research and business belong together and both are needed. In a rapidly developing life science industry, thereis an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach studentsabout concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.
Expected Outcome	The student will be able to conceptualize Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.
Unit-I	**Innovation and entrepreneurship in bio-business**
Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	
Unit- II	**Bio markets - business strategy and marketing**
Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	
Unit-III	**Finance and accounting**
Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	
Unit-IV	**Technology management**
Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).	
Reference books	1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion. 2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge. 4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press. 5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic	

council on:	

SC640	**VIROLOGY**
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sen- sitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identifica- tion of individuals predisposed to disease ranging from common cold to cancer. ● .
Expected Outcome	Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
Unit-I	**Classification, Morphology and Chemistry of Viruses**
Virus evolution and classification, properties of viruses, virus structure. Working with viruses: Techniques for visualisation and enumeration of viral particles, measuring biological activity of viruses, assays for virus estimation and manipulation, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses. HDV, Prions and Viroids.	
Unit- II	**Pathogenesis of viral infection and replication pattern**
Stages of infection, Patterns of some viral diseases- epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses.	
Unit-III	**Working with viruses**
Techniques for visualisation and enumeration of viral particles, measuring biological activity of viruses, assays for virus estimation and manipulation, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses.	
Unit-IV	**Plant and microbial viruses**
Significance of plant virology and modern classification of plant viruses and viroids according to ICTV; and cryptograms of various plant viruses and virus groups. General discussion on symptoms caused by viruses and viroids in diseased economically important trees and agricultural crops, and their control including development of virus disease resistant transgenetics. Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses.	
Unit-V	**Anti-viral strategies-prevention and control of viral diseases**

Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Contributions of various host defense mechanisms in viral infections; Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotype and DNA vaccines.	
Reference books	Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004. 1. 2. 3. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005 Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC638	**MICROBIAL PHYSIOLOGY AND METABOLISM**
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sen- sitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identifica- tion of individuals predisposed to disease ranging from common cold to cancer. ● .
Expected Outcome	Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Unit-I	Growth, Cell division and Solute transport
Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth. Solute Transport: Primary and Secondary transport: Introduction, ABC transporters, , Drug export systems, amino acid transport.	
Unit- II	**Central Metabolic Pathways and Regulation:**
Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA and Reverse TCA, glyoxylate cycle. Utilization of sugars other than glucose and complex polysaccharides	
Unit-III	**Nitrogen metabolism**
Metabolism of amino acids: Amino acid biosynthesis and utilisation, lysine and glutamine overproduction, stringent response, polyamine biosynthesis and regulation.	
Unit-IV	**Metabolism of lipids, hydrocarbons and nucleotides**
Metabolism of lipids and hydrocarbons: Lipid composition of microorganisms, biosynthesis and degradation of lipids, lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation. Metabolism of nucleotides: Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.	
Unit-V	**Physiological adaptations and intercellular signaling**
Introduction to two component system, regulatory systems during aerobic- anaerobic shifts: Quorum sensing: A and C signaling system, sporulation in Bacillus subtilis, control of competence in Bacillus subtilis. Heat-Shock responses, pH homeostasis, osmotic homeostasis.	
Reference books	1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc., 2008. 2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008. 3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988. 4. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002 5. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	

Approved by academic council on:	

SM 508	RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Version	II
Prerequisite	All students are expected to have a basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are togive background on history of science, emphasizing methodologies used todo research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics. about biotechnology, To have understanding about nature of damage, Able to analyse gene clonning management.
Expected Outcome	The student will be able to conceptualize : Understand 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.
Unit-I	**History of science and science methodologies**
Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology. .	
Unit- II	**Preparation for research**
Choosing a mentor, lab and research question; maintaining a lab notebook.	
Unit-III	**Process of communication**
Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences;	
Unit-IV	**Presentation skills**
Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.	
Unit-V	**Scientific communication**
Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	
Reference books	1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press. 2. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press. 3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78 (Nov-Dec 1990), 550-558. 4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SM 611	CRITICAL ANALYSIS OF CLASSICAL PAPERS
Version	II
Prerequisite	All students are expected to have a basic knowledge of biology and chemistry.
Learning objective	The objectives of this course are to familiarize students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.
Expected Outcome	The student will be able to conceptualize about : Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.
	How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed. A list of sixteen classic papers and some suggested reference materials:
Unit-I	**MOLECULAR BIOLOGY (Any Four Paper)**

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III.Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58. **Note:** This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.**Note:** Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8**Note:** In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated.
4. Transposable mating type genes in *Saccharomyces cerevisiae* James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979 .**Note:** This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. 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:** The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology" .
6. *In vivo* alteration of telomere sequences and senescence caused by mutated *Tetrahymena* telomerase RNAsGuo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990 **Note:** This paper demonstrates that the telomerase contains the template for telomere synthesis

Unit- II	**Cell Biology (Any Four)**

1. A protein-conducting channel in the endoplasmic reticulumSimon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80 **Note:** This paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis
2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15 **Note:** In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion.
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulumDeshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45**Note:** Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the GolgiBalch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16 **Note:** This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombinationBrack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14 **Note:** This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87 **Note:** This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.

Developmental biology and genetics	.Mutations affecting segment number and polarity in *Drosophila*Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980**Note:** This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.Information for the dorsal--ventral pattern of the *Drosophila* embryo is storedas maternal mRNAAnderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 **Note:** This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genesHedgehog signalling in the mouse requires intraflagellar transport proteins Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.;Nature. 2003 Nov 6;426(6962):83-7**Note:** One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role ofcillia in

	it.Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SM 609	PROJECT PROPOSAL PREPARATION AND PRESENTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Plant and Animal Biotechnology.
Learning objective	The learning objective of course are: to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Expected Outcome	The student will be able to conceptualize about ● Formulate a scientific question; ● Present scientific approach to solve the problem; ● Interpret, discuss and communicate scientific results in written form; ● Gain experience in writing a scientific proposal; ● Learn how to present and explain their research findings to the audience effectively.
Unit-I	**Project proposal preparation**
Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.	
Unit- II	**Poster presentation**
Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.	
Unit-III	**Oral presentation**
At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by Academic council on:	

SC 602	DISSERTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Microbiology and basic principles of Chemistry.
Learning objective	The learning objectives of 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.
Expected Outcome	The student will be able to conceptualize about 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.
Unit-I	**Planning and performing experiments**

Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.	
Unit- II	**Thesis writing**
At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.	
Mode of Examination	student seminar/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 620	GENOMICS AND PROTEOMICS
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.
Expected Outcome	The student will be able to conceptualize knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
Unit-I	**Basics of genomics and proteomics**
Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.	
Unit- II	**Genome mapping**
Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.	
Unit-III	**Genome sequencing project**
Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.	
Unit-IV	**Comparative genomics and proteomics**
Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence. Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.	
Unit-V	**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 function- forward and reverse genetics, gene ethics; protein- protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.	
Reference 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. 2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press. 3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended	

By BOS on:	
Approved by academic council on:	

SM 642	**MICROBIAL PATHOGENICITY**
Version	II
Prerequisite	All students are expected to have a basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are togive background on history of science, emphasizing methodologies used todo research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics. about biotechnology, To have understanding about nature of damage, Able to analyse gene clonning management.
Expected Outcome	The student will be able to conceptualize : Understand 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.
Unit-I	**History of science and science methodologies**
Classical view of microbial pathogenicity: Define pathogenicity and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD_{50}, ID_{50}, $TCID_{50}$. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate coordinated regulation of virulence genes, two component signal transudation systems and environmental regulation of virulence determinants, antigenic variation; clonal and panmictic nature of microbial pathogens, type 1-IV secretion systems, biofilms and quorum sensing. intracellular intracellular pathogens.	
Unit- II	**Environment change and infectious diseases**
Global warming lead increase in vector-borne and water-borne infectious diseases; Impact of increasing urbanization, international travel and trade on infectious diseases.	
Unit-III	**Antimicrobial resistance**
Antimicrobial resistance: Recent concepts – Multidrug efflux pumps, extended spectrum β-lactamases (ESBL), X- MDR M. tuberculosis, Methacillin-resistant S. aureus (MRSA).	

Unit-IV	Newer vaccines and rapid diagnostic principles
Recombinant vaccines, subunit vaccines, DNA vaccines, Vaccinia, BCG and HIV– vector based vaccines, Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, diagnostic sequencing and mutation detection, molecular typing methods, array technology.	
Unit-V	**Emerging and re-emerging pathogens**
Emerging and re-emerging pathogens: Illustrate emerging and re-emerging pathogens using V. cholerae O: 139, X-MDR M. tuberculosis, Helicobacter pylori, Enterohaemorrhagic E. coli (EHEC), Cryptosporidium parvum, Lyme disease, SARS virus, Bird flu, prions, AIDS, Dengue Hemorrhagic Fever, and Chlamydiae, opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: microbial change and adaptation, horizontal gene transfer (HGT), pathogenicity islands (PAI), role of integrons.	
Reference books	1. Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004. 2. 3. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Society for Microbiology Press. 2005. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley-VCH. 2006. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM, Graham NMH eds. An Aspen Publication. 2001.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SCHOOL OF APPLIED SCIENCES
M.Sc. Microbiology
DETAILED SYLLABUS

DI 602 DISSERTATION/ PROJECT WORK **C (L, T, P) = 14 (0, 0, 0)**

CLASS IV Sem M.Sc. Microbiology	**EVALUATION**
Schedule Per Week Practicals:	Examination Time = Three (3) Hours Max. Marks =100 [Internal Assesment (60) & Semester End Exam (40)]

The Project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation of the work done. The dissertation submitted by the candidate shall be evaluated by one External expert ,Head of the Department and supervisor of the candidate. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under.

Max. Marks:- 100

Dissertation Record	60 marks
Viva Voce	40 marks
Total	100 marks

Scheme of Examination
General Guide-lines for Course of Study

1. The whole syllabus is divided into five units.
2. Number of teaching hours required to finish the contents of each unit are mentioned in the syllabus.
3. Books recommended/references are given at the end of each paper separately.
4. In P.G. programme list of periodicals for consultation are also given.
5. Two questions will be set from each unit and student will have to attempt one question from each unit.
6. Maximum time allowed for answering each question paper is 3 hours.
7. Maximum marks allotted to a paper are 70.

Examination Pattern

Evaluation will be done under two headings:

1. Theoretical Examination & Sessional
2. Practical Examination & Sessional
3.

1. Theoretical Examination (100 Marks):

This will be further divided under two categories

(i) Internal Assessment	: 40 Marks	(40% Component)
(ii) End term Assessment	: 60 Marks	(60% Component)

(i) Internal Assessment (40 Marks): This is the 40% component of the total 100% theoretical examination & is further divided as follows

Process	Mid Term I	Mid Term II	Weekly Tests (1+1)	Assignment (1+1)	Total
Marks	10	10	05+05=10	05+05=10	40

Two Mid Term Examinations, Two Weekly Tests per subject and two assignments from each unit will be conducted for assessment as per the following schedule:

- After Completion of 1st Unit : Weekly test - I (to cover unit – I) and 2 assignments
- After Completion of 2nd Unit : Mid Term Exam-I and 2 assignments (to cover unit 1 & 2)
- After Completion of 3rd Unit : Weekly test – II (to cover unit 3) and 2 assignment
- After Completion of 4th Unit : Mid Term Exam – II & 2 assignments (to cover unit – 3 & 4)
- After Completion of 5th Unit : End Term Exams & 2 assignments (to covers all 5 units)

After completion of each unit, two assignments from each unit are to be given to the students, which will be submitted by the student after two working days. Thus total of 10 assignments will be assessed per semester. The Mid Term examination will be of 90 Min. duration and the concerned faculty members will be responsible for

the question papers & evaluation.
Mid Term marks will be displayed within two working days of exams.

(ii) End Term Assessment (70 Marks): End term examination will be of 3.00 hrs duration and the question paper and the evaluation system will be as follows

Question Paper: For paper setting each subject, paper should be sent to three paper setters randomly and then any one paper will be selected randomly.

Evaluation System: Final result will be declared within one month after completion of examination. Centralized evaluation will be undertaken for End Term examinations.

2. Practical Examination &Sessionals (100 Marks):

The practical examination is also further divided into two categories i.e.

(i) Internal Assessment	: 60 Marks	(60% Component)
(ii) End Term Assessment	: 40 Marks	(40% Component)

(i) Internal Assessment (60 Marks): This is the 60% component of the total 100% practical examination and is further divided as follows

Process	Lab	Attendance	File work	Lab Project	Viva Voice	Total
Marks	10	10	10	20	10	60

- The internal exam component will be awarded on the basis of total number of experiments conducted during the practical classes.
- Marks of attendance will be awarded based on percentage of attendance. The students will be detained if the total percentage falls below 75% in all subjects taken together.
- The file work will depend on the submission of detailed theory & experimented record.
- Overall presentation on the practicals performed during the semester will be taken into consideration for award of marks.
- Internal viva on the practicals performed will form the basis for award of marks in Viva-Voce.

(iii) End Term Assessment (40 Marks): This examination will be final practical examination the evaluation of the final examination should be done on same day as given below:

(iv)

Process	Performance of the practical	Quiz	Viva voce	Total
Marks	15	15	10	40

Mid-Term exams, weekly test and assignment will be reflected in the academic calendar.

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

SCHOOLOFAPPLIEDSCIENCES

M.Sc. Virology & Immunology

SYLLABUS

EDITION 2021-23

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year:2021-23 Program

School of Applied Sciences **Program: M. Sc. Virology & Immunology** **Semester:I**

S.No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage(in%)	
					L	T/S	P		CIE	ESE
1.	PC-501	Proficiency in Co-Curricular Activity	UniversityCore	2	0	0	0		100	
2.	SC501	Biochemistry	Program Core	3	3	0	0	3	40	60
3.	SC503	Immunology and Immuno Technology	Program Core	3	3	0	0	3	40	60
4.	SC505	Cell and Molecular Biology	Program Core	3	3	0	0	3	40	60
5.	SC 509	Basics of Virology	Program Core	2	3	0	0	3	40	60
6.	SC507	Bioanalytical Techniques	Program Core	3	3	0	0	3	40	60
7.	SC551	Cell and Molecular Biology Lab	Program Core	2	0	0	3	3	60	40
8.	SC553	Biochemistry Lab	Program Core	2	0	0	3	3	60	40
9.	SC555	Immunology and ImmunotechnologyLab	Program Core	2	0	0	3	3	60	40
10.	SC557	Bioanalytical Tech Lab	Program Core	2	0	0	3	3	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

SURESH GYAN VIHAR UNIVERSITY

Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-23 Program

School of Applied Sciences Program : M. Sc. Virology & Immunology Semester : II

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage(in %)	
					L	T/S	P		CE	ESE
1.	EM-502	Employability Skills	UniversityCore	1	1	0	0	3	60	40
2.	PC-502	Proficiency in Co-Curricular Activity	UniversityCore	2	0	0	0	0	100	
3.	SC502	Genetic Engineering and Application	Program Core	3	3	0	0	3	40	60
4.	SC510	Virology and Virological Methods	Program Core	3	3	0	-	3	40	60
5.	SC506	Bioinformatics	Program Core	3	3	0	-	3	40	60
6.	SC508	Research Methodology and Scientific communication Skills	Program Core	2	0	0	2	3	60	40
7.		Elective I	Program Core	3	3	0	-	3	40	60
8.	SC 552	Genetic Engineering and Application Lab	Program Core	2	0	0	3	3	60	40
9.	SC560	Virology and Virological Methods Lab	Program Core	2	0	0	3	3	60	40
10.	SC 556	Bioinformatics Lab	Program Core	2	0	0	3	3	60	40
11.	SM 558	Seminar– I	Program Core	1	1	0		0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective Subject:-

1. Nanobiotechnology (SC604)
2. Vector Biology (SC642)
3. Drug Designing and Development (SC632)
4. Advanced Clinical Biochemistry (SC634)

5. Antivirals and Vaccine Development (SC636)
6. Viral Diseases and Cancer (SC644)
7. Bio-entrepreneurship and Bio-business management (SC626)

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year : 2021-23 Program

School of Applied Sciences Program : M. Sc. Virology & Immunology Semester : III

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CE	ESE
1.	EM-601	Employability Skills II	University Core	1	1	0	0	3	60	40
2.	PC-601	Proficiency in Co- Curricular Activity	University Core	2	0	0	0		100	
3.	SC615	Virus Cell Interaction and Replication	Program Core	3	3	0	0	3	40	60
4.	SC613	Basic and Applied Epidemiology	Program Core	3	3	0	0	3	40	60
5.	SC605	Biostatistics	Program Core	3	3	0	0	3	40	60
6.	SC 607	Intellectual Property Rights, Biosafety and Bioethics	Program Core	3	3	0	0	3	40	60
7.		Elective II	Program Core	3	3	0	-	3	40	60
8.	SC609	Project Proposal Preparation and Presentation	Program Core	2	0	0	3	3	60	40
9.	SC 611	Critical Analysis of Classical Papers	Program Core	2	0	0	3	3	60	40
10.	SC 661	VirologyLab I	Program Core	2	-	0	3	3	60	40
11.	SC 663	Virology Lab II	Program Core	2	-	0	3	3	60	40
12.	SC655	Industrial Summer Project	Program Core	4	0	0	0		60	40
13.	SC657	Seminar-II	Program Core	1	-	0	0	0	60	40

L – Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Elective Subject:

1. Fermentation Technology (SC646)
2. Food and Dairy Technology (SC616)
3. Genomics & Proteomics (SC620)
4. Plant and Animal Tissue Culture (SC648)

5. Molecular Diagnostics (SC650)
6. Emerging Technologies (SC652)

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year : 2021-23 Program

School of Applied Sciences **Program: M. Sc. Virology & Immunology** **Semester: IV**

S. No.	Course Code	Course Name	Type of Course Core/Elective	Credits	Contact Hrs/Wk.			Exams Hrs	Weightage(in %)	
					L	T/S	P		CE	ESE
1.	SC602	Dissertation/Project work	Program Core	20	-	-	-	2	-	100

Signature of Concerned Teacher **Signature of Convener BOS**

Signature of Member Secretary

SC501	BIOCHEMISTRY
Version	III
Prerequisite	All students are expected to have a general knowledge of bio molecules and its chemistry.
Learning 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. •
Expected Outcome	On completion of this course, students should be able to: • Gain fundamental knowledge in biochemistry; • Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.

Unit-I	**Chemical basis of life**
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.	
Unit-II	**Carbohydrate**
Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	
Unit-III	**Protein structure and enzyme kinetics**
Amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification 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; concept of catalytic antibodies	
Unit-IV	**Structure and function of DNA, RNA and Lipids**
Self-assembly of lipids, micelle, biomembrane 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.	
Unit-V	**Role of vitamins & cofactors in metabolism**
Vitamins and their role in daily life. 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 pathway.	
Reference books	1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. 2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth. 3. Voet, D., &Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons. 4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. 5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American,264(1), 54-63.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination /PPT
Recommended By BOS on:	
Approved by academic Council on:	

SC503	**IMMUNOLOGYANDIMMUNOTECHNOLOGY**
Version	III
Prerequisite	All students are expected to have knowledge of immune system and viruses.
Learning objective	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by

	designing new experiments.
Expected Outcome	On completion of this course, students should be able to: • Evaluate 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).
Unit-I	**Immunology: fundamental concepts and overview of the immune system**

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

Unit-II	**Immune responses generated by B and T lymphocytes**

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Unit-III	**Antigen-antibody interactions**

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit-IV	**Vaccinology**

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Unit-V	**Clinical immunology**

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immune deficiencies, acquired or secondary immune deficiencies, autoimmune disorder, anaphylactic shock, immune senescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Reference books	1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman. 2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub. 3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science. 4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press. 5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press. 6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	

Approved by academic council on:	

SC505	CELL AND MOLECULAR BIOLOGY 3
Version	III
Prerequisite	Allstudentsareexpectedto havea basic knowledgeofcell and it organelles.
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. ● To create an understanding about cause of cancer and the mechanism involve in cancer regulation. .
Expected Outcome	Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?
Unit-I	**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: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	
Unit-II	**Celldivisionandcellcycle**
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 signaling; cell motility and migration; cell death: different modes of cell death and their regulation.	
Unit-III	**Cellular signaling, 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.	
Unit-IV	**Chromatin structure and dynamics**
Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin- Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs).	
Unit-V	**Genome instability and cell transformation**
Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, 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.	
Reference 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. 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. 3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning. 4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings. 6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	

Approved by academic council on:	

SC 509	**Basics of Virology**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of basic microbiology.
Learning objective	The learning objective of course are: To create an understanding regarding the virology.
Salient features	The student will be able to conceptualize basics of virology
Unit-I	**History and principles of virology** **5 hours**
	History and principles of virology, virus taxonomy, introduction to replication strategies.
Unit-II	**Structure of viruses** **4 hours**
	Virus structure and morphology, Viruses of veterinary importance
Unit-III	**Biosafety** **5 hours**
	Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory.
Unit-IV	**Plant Viruses 5 hours**
	Plant viruses, plant virus propagation
Unit-V	**Bacteriophages & Viroids** **5 hours**
	Bacteriophages, bacteriophage propagationand viroids.
Reference books	1. Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), 3rd Edition. Lippincott-Raven, Philadelphia, PA. 2. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka. Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology--- Chapters 3-13. 3. Laboratory Animal Medicine: Principles and Procedures. Margi Sirois. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences. 4. Guides for the Care and Use of Laboratory Animals. National Research Council. Latest edition / Pub. Date: January 1996. Publisher: National Academy Press. 5. Laboratory Biosafety Manual, WHO, http://www.who.int/csr/resources/publications/biosafety/who_cds_csr_l yo_20034/en/ 6. Virology: 1994. 3rd ed. FrankelConrat et al, Prentice Hall. 7. Introduction to Modern Virology. 2001. 5th ed. Dimmock et al., Blackwell Scientific Publ. 8. Basic Virology, 1999. By Waginer and M. Hewlett, Blackwell Science Publ.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 507	**Bio analytical techniques**
Version	I
Prerequisite	All students are expected to have a basic knowledge of tools and techniques used in life sciences.
Learning objective	The learning objective of course are: ● To create an understanding regarding the technical applications of various tools which are being used in life sciences. ● To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
Expected Outcome	Thestudentwillbeabletoconceptualize abouttoolsandtechniqueusedinlife sciences and Abletounderstand instrumentationinlife science.
Unit-I	**Principles and applications of Microscopy**
Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.	
Unit-II	**Spectrophotometry**
Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology.	
Unit-III	**ChromatographicTechniques**
Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.	
Unit-IV	**Electrophoresis**
Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Isoelectric focusing. Isotachophoresis. 2-D Electrophoresis, Capillary electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis, Immunostaining and DNA finger printing and ELISA.	
Unit-V	**Radiotracer technique**
Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non-radiolabelling.	
Reference Books	1. Nuclear Magnetic Resonance: Williams 2. Biochemical Techniques theory and practice: White R 3. Analytical Chemistry: Christion G. D. 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H. 5. An Introduction to Practical Biochemistry: Plummer D. T. 6. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982 7. Tools in Biochemistry David Cooper 8. Methods of Protein and Nucleic acid Research, Osterman Vol I – III 9. Centrifugation D. Rickwood 10. Practical Biochemistry, Vth edition, Keth, Wilson and Walker.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

SC510	**Virology and Virological Methods**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of virology.
Learning objective	The learning objective of course are: To create an understanding regarding the Oncogenic viruses and pathogenesis of cancer.
Salient features	The student will be able to conceptualize basics to advance of croos talk between virology and oncology.
Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Principles of virology7 hours**
	History and principles of virology, virus taxonomy, introduction to replication strategies. Virus structure and morphology. Viruses of veterinary importance. Principles of bio-safety, containment facilities, maintenance and handling oflaboratory animals and requirements of virological laboratory. Plant viruses, plant virus propagation. Bacteriophages, bacteriophage propagation and viroids.
Unit-II	**Purification of viruses**
	In vivo, in vitro and in ovo systems for virus growth, estimation of yields,methods for purification of viruses with special emphasis on ultracentrifugationmethods.
Unit-III	**PCR,ELISA 7 hours**
	Introduction to PCR,ELISA
Unit-IV	**Immunodiagnosis7 hours**
	Immunodiagnosis, IFA, haemagglutination and haemagglutination-inhibition tests, Complement fixation, neutralization, Western blot, RIPA andimmunohistochemistry.
Unit-V	**Principles andapplications8 hours**
	Fluorescence, confocal and electron microscopic techniques - principles and applications.
Reference books	1. Fields Virology, Volume 2, 4th edition:(2001). 2. Clinical Virology, Second Edition (Richmans Hayden). 3. Hepatitis Viruses (Japan medical research fourm). 4. Viral Hepatitis and Liver disease, A.J. Zuckerman. 5. Viral Infection of Humans (S. Svans& A Kaslow). 6. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC506	BIOINFORMATICS
Version	II
Prerequisite	Allstudentsareexpectedto havea generalknowledgeofbiologyandchemistrybasicprinciples.
Learning objective	The objectives of this course are to provide theory and practical experience of theuse of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
Expected Outcome	Thestudentwillbeabletoconceptualize about ● 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.
Unit-I	**Introductionto Bioinformatics**
Bioinformatics basics: Computers in biology and medicine; Introduction to Unixand Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; 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.	
Unit-II	**DNA sequence analysis**
DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pair wise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.	
Unit-III	**Multiple sequence analysis**
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: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.	
Unit-IV	**Protein modelling**
Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; 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.	
Unit-V	**Protein structure prediction and virtual library**
Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure prediction on a mystery sequence; 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; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design; Virtual library: Searching PubMed, current content, science citation indexand current awareness services, electronic journals, grants and funding information.	
Reference books	1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press. 2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience. 4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture and Function*

Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC615	**Virus Cell Interaction and Replication**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of virology.
Learning objective	The learning objective of course are: To create an understanding regarding the Oncogenic viruses and pathogenesis of cancer.
Salient features	The student will be able to conceptualize basics to advance of croos talk between virology and oncology.
Utility	A degree in Virology and Immunology allows students to understand the interaction pattern of viruses with human beings and their replication startegies
Unit-I	**Introduction**
	Definition, structure and methods of discovery of viral receptors (polio, herpes,VSV, HIV). Kinetics of receptor binding. Cellular interactions—clathrin coated pits,lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Nuclearlocalization signals and nuclear pore transit, virus –cytoskeletal interactions,chaperons.
Unit-II	**Replication**
	Replication sites and their characterization, IRES, replicons, transport of viralproteins. Host cell 'shut off', apoptosis, necrosis, stress response, alteration of signalingpathways, cellular basis of transformation, types of cenotaphic effects,ultrastructural cytopathology.
Unit-III	**Cellular injury associated markers7 hours**
	Cellular injury associated markers, mechanism of viral persistence and latency, invivo and in vitro models (JE, measles, LCM and HIV).
Unit-IV	**General strategies 7hours**
	General strategies, replication of positive sense RNA virus (polio), negative sense RNA viruses (VSV and influenza). Replication of double stranded RNA virus (Rotavirus), ambisense RNA (LCM) andretroviruses (HIV and HTLV).
Unit-V	**Replication 8 hours**
	Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV), Prion proteins, replication of plant virus (Poty).
Reference books	1. Fields Virology, Volume 2, 4th edition:(2001). 2. Clinical Virology, Second Edition (Richmans Hayden). 3. Hepatitis Viruses (Japan medical research fourm). 4. Viral Hepatitis and Liver disease, A.J. Zuckerman. 5. Viral Infection of Humans (S. Svans& A Kaslow). 6. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC613	**Basic and Applied epidemiology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Historical aspects07 hours**
Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology. Descriptive and analytical epidemiology, disease burden, natural history of diseases and measures of risk and death. Sample size estimation and introduction to study design in epidemiological investigations.	
UNIT-II	**Types and methods of public health 08 hours**
Types and methods of public health and infectious disease surveillance, establishing surveillance system.	
UNIT –III	**Case control and cohort studies.06 hours**
Case control and cohort studies.	
UNIT-IV	**Outbreak investigations 07 hours**
Needs and steps to be taken for outbreak investigations, collaboration with State and National health authorities.	
UNIT-V	**Veterinary Epidemiology 07 hours**
Veterinary Epidemiology	
Text Book	*Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.*
Reference Books	1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press. 2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences. 3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press. 4. Epidemiology: Beyond the Basics. F. Javier Nieto, MoysesSzklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc. 5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004. 6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub. Date: April 2005. Publisher: SAGE Publications.
Mode of	

Evaluation: (Percent Weight-age)	
Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

SC605	**BIOSTATISTICS**
Version	III
Prerequisite	All students are expected to have a general knowledge of Mathematics.
Learning objective	The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.
Expected Outcome	The student will be able to conceptualize about ● Scope of Biostatistics ● Correlation and regression ● Bioinformatics and Databases ● Sequence Analysis
Unit-I	**Definitions Scope of bio statistics**
Definitions Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data–Graphical and diagrammatic representation–scale diagrams–histograms–frequency polygan– Frequency curves. Measures of central tendency–arithmetic mean, median and mode–calculation of mean, median & mode in series of individual observations, discrete series continuous open – end classes.	
Unit I	**Correlation**
Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions Bivariate Data: Scatter diagram. Correlation and regression Simple correlation – correlation coefficient. Regression-simple,linearregression. Correlation coefficient and its properties, Correlation ratio. Rank – Spearman's and Kendall's measures of correlation.	
Unit-II	**Regression**
Principle of least squares, linear regression, fitting of curves reducible to polynomials by transformation. Multiple regression, Multiple and partial correlation coefficients. Basic ideas of significance test–Hypothesistesting level of significance–Test based onstudent't' *'chi'*squareandgoodnessof fit.'F'test-ANOVA.	
Unit-V	**Probability and hypothesis testing**
Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.	
Unit-V	**Population Statistics**
Concepts of population and sample, advantages of sampling, census and sample surveys, Basic concepts in sampling and designing of a large scale surveys. Types of sample – the convenience sample, Judgment sample and the probability sample; simple random sampling with and without replacement. Unit II Systematic sampling, Stratified sampling, Estimation of mean, Proportion and standard error using the above probability sampling, probability proportional to size sampling, Estimation of sample size for clinical experiments, sources of error in surveys.	
Reference books	1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan. 2. Aitken, M., Broadhursts, B., &Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science. 3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley. 4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press. 5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*.

Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 607	INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS
Version	II
Prerequisite	All students are expected to have a general knowledge of biologyand Stem cell.
Learning objective	The learning objective of course is:Tocreate an understanding regarding the Stem cell biology, their types and Application.
Expected Outcome	The student will be able to conceptualize about:intellectual property rights, biosafety and bioethics

Unit-I **Introduction to IPR**

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit-II **Patenting**

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India.

Unit-III **Biosafety**

Biosafety and Biosecurity - introduction; biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levelsfor infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; conceptsof familiarity and substantial equivalence; risk – environmental risk assessment andfood and feed safety assessment;

Unit-IV **National and international regulations**

International regulations – Cartagena protocol, OECD consensus documents andCodex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft billof Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit-V **Bioethics**

Introduction, ethical conflicts in biological sciences - interference with nature,bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Reference books

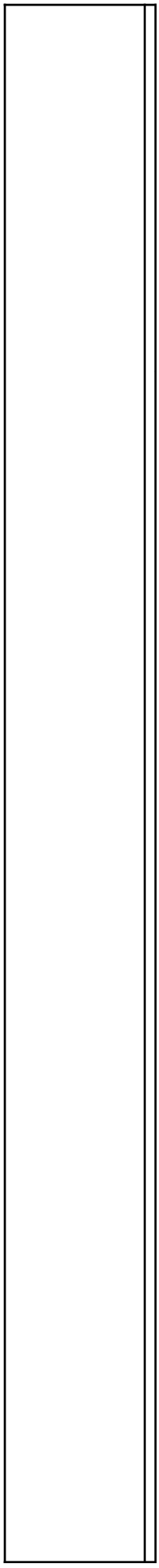
1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf
13. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
14. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp

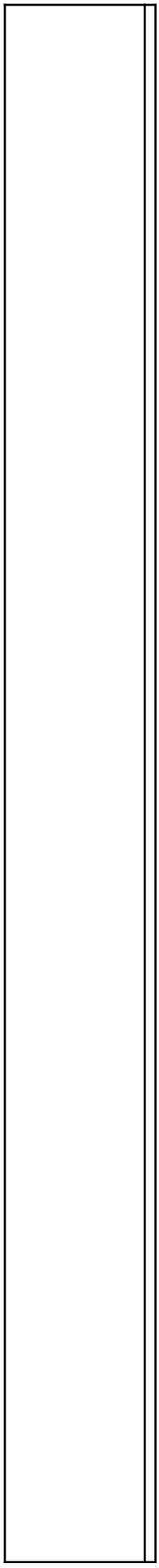
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC609

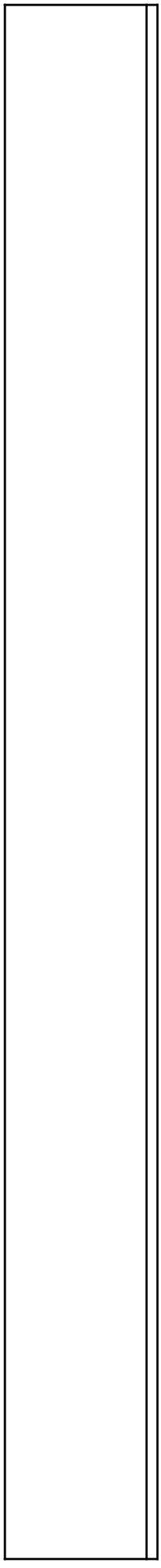
Version	I I
Prerequisite	

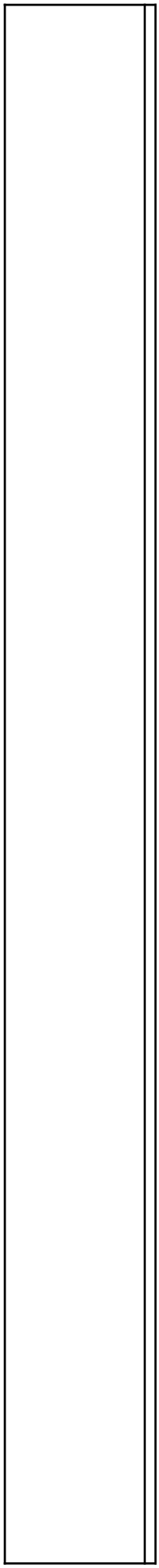
Learning objective

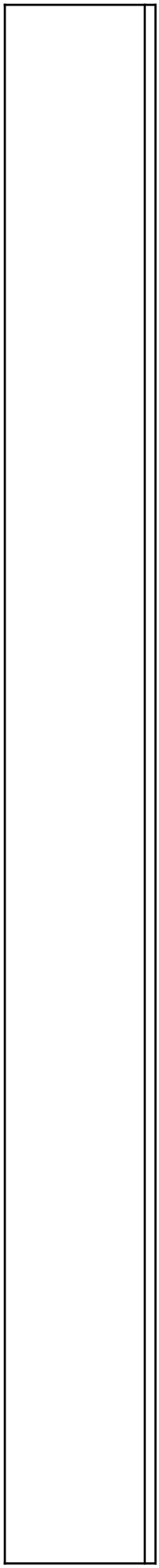


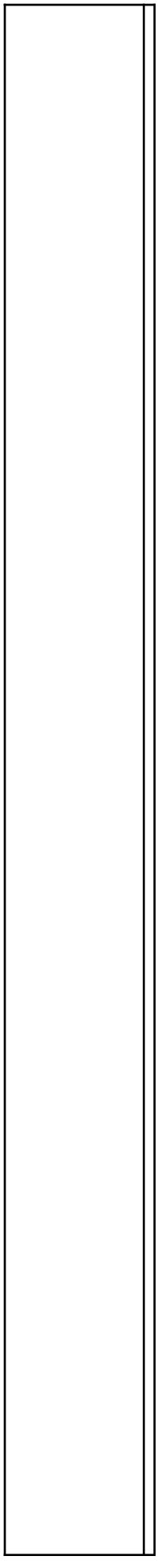


Expected Outcome









Unit-I

Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection,

etc. Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.
Unit-II
Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.
Unit-III

At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	
Mode of Examination	

Recommended By BOS on:	
Approved by academic council on:	

SC611	CRITICAL ANALYSIS OF CLASSICAL PAPERS
Version	III
Prerequisite	All students are expected to have a basic knowledge of biologyand chemistry.
Learning objective	The objectives of this course are to familiarize students with classic literature to make them appreciate how ground- breaking discoveries were made without, necessarily, use of high-end technologies.
Expected Outcome	Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.
	How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed. A list of sixteen classic papers and some suggested reference materials:

Unit-I MOLECULAR BIOLOGY (Any Four Paper)

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58. **Note:** This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.

2. Independent functions of viral protein and nucleic acid in growth of bacteriophage Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56. **Note:** Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.

3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8. **Note:** In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated.

4. Transposable mating type genes in *Saccharomyces cerevisiae* James Hicks, Jeffrey N. Strathern& Amar J.S. Klar; Nature 282, 478-483,1979 .**Note:** This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.

5. 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:** The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology" .

6. *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 **Note:** This paper demonstrates that the telomerase contains the template for telomere synthesis

Unit-II CELL BIOLOGY (Any Four)

1. A protein-conducting channel in the endoplasmic reticulum Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80 **Note:** This paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15 **Note:** In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion.

3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45 **Note:** Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC.

4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16 **Note:** This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*

5. A complete immunoglobulin gene is created by somatic recombinationBrack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14 **Note:** This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.

6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87 **Note:** This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.

Unit-III Developmental biology and genetics

1. Mutations affecting segment number and polarity in *Drosophila* Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980 **Note:** This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.

2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 **Note:** This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes.

3. Hedgehog signalling in the mouse requires intraflagellar transport proteins Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7 **Note:** One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway.

4. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it. Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC502	**GENETICENGINEERING AND APPLICATION**
Version	III
Prerequisite	All students are expected to have a general and basic knowledge of molecular biology and Genetics.
Learning Objective	The learning objectives of course are: to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.
Expected Outcome	Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.
Unit-I	**Introduction to tools for genetic engineering**
Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ*hybridization.	
Unit-II	**Vectors in genetic engineering**
Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	
Unit-III	**PCR techniques**
Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products;T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP,	

DGGE, RFLP.	
Unit-IV	**Gene manipulation and protein DNA interaction**
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
Unit-V	**Gene silencing and genome editing technologies**
Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.*fruit flies gene targeting; creation of transgenic and knock-out mice; disease model;	
Reference books	1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications. 2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science. 5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc*.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Electives

SC604	**Nanobiotechnology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Introduction of nanobiotechnology 08 hours**
Introduction, history and Timeline of Nanobiotechnology, Development ofnanobiotechnology – timelinesand progress, overview.	
UNIT-II	**Synthesis and Characterization of nanomaterials 08 hours**
Nanomaterials for Biotechnological Applications, Carbon Nanotubes, Nanowires, synthesizing nanoparticles, Green synthesis of nanoparticles, characterization of nanoparticles.	
UNIT –III	**Nano-biotechnology detection system06 hours**
Varioustypes of transducing elements and their applicationsin Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticle as biosensors, DNA detection, small scale system for drug delivery.	
UNIT-IV	**Nanobiotechnology in chronic and infectious disease 07 hours**
Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis andTherapy	

UNIT-V	**Nanobiotechnology in environment and food sciences 07 hours**
Nanobiotechnology in environment, detection of food contaminants, food industry, Food preservation, waste water treatment.	
Text Book	*Bionanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation: (Percent Weight-age)	
Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

SC642	**Vector Biology**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of vector
Learning objective	The learning objective of course are: To create an understanding regarding the vector biology
Salient features	The student will be able to conceptualize basics of vector biology
Unit-I	**Introduction 5 hours**
	Introduction to general entomology, insect morphology and classification. Insectsand other arthropods of medical importance and their structures and functions.Methods for collecting these insects and arthropods, their preservation/maintenance and transportation.
Unit-II	**Biology and life history4 hours**
	Biology and life history of *Aedes, Culex* and *Anopheles* mosquitoes*,* their behaviour and ecology with special reference to dengue, chikungunya, Japanese encephalitisand West Nile virus.
Unit-III	**Disease relationship5 hours**
	Biology, morphology and disease relationship of sandflies (sandfly fever andchandipura). Biology and morphology of fleas, lice, culicoides. Biology, ecology,life history of ticks with special reference to Kyasanur Forest Disease (KFD,CCHF). Biology and morphology of mites.
Unit-IV	**Vector virus relationship5 hours**
	Vector virus relationship: Virus dissemination & mechanism of virus transmissionin vectors, natural cycle, maintenance of viruses in nature, basis of vectorcompetence, mechanical transmission, virus dissemination, susceptibility-intrinsicand extrinsic factors. Xenodiagnosis- methods and application.
Unit-V	**Vector Control 5 hours**
	Vector Control: Various control strategies and environmental management.Control in urban settings, control at aquatic stages, adult population, personalprotection, insecticide resistance mechanism and control dynamics.
Reference books	1. Gordon RM, Lavoipierre MMJ (1962) *Entomology for students of Medicine*. Blackwell Scientific Publ. 2. Service MW (1996) *Medical entomology for students*. Chapman and Hall 3. Kettle DS (1984) Medical and veterinary entomology CAB international 4. Richard and Davies Imm's general Text book of Entomology, Vol I & II. Chapman and Hall 5. Roy DN and Brown AWA (1970) Entomology (Medical & veterinary) Bangalore printing and Publishing co. 6. Bates M (1949) Natural History of mosquitoes The Macmillan Co 7. Baker RH and Wharton R(1952) Introduction to Acarology The Macmillan Co
Mode of Examination	
Recommended By BOS on:	
Approved by academic council on:	

SC632	**Drug Designing and Development**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs
Learning objective	The learning objective of course are: To create an understanding regarding the Basics of Molecular Modelling and Drug Designing
Salient features	The student will be able to conceptualize basics to advance of Basics of Molecular Modelling and Drug Designing.

Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Biotechnological products 8 hours**
	Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.
Unit-II	**Basic principles of molecular dynamics 7 hours**
	Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting,Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors forendogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.
Unit-III	**Vaccines 7 hours**
	Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptidevaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotypevaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novelvaccine delivery systems.
Unit-IV	**Drug Design 7 hours**
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) &Hans equation
Unit-V	**Molecular Modelling 7 hours**
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.
Reference books	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England, 1996. 2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000. 3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003. 4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego, 1996. 5. D. Frenkel and B. Smith, Understanding Molecular Simulations. From Algorithms to Applications, Academic Press, San Diego, California, 1996. 6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984. 7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, New York, 1986. 8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids. Cambridge University Press, Cambridge, 1987. 9. D.C. Rapaport. The Art of Molecular Dynamics Simulation.Cambridge University Press, Cambridge, England., 1995
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC634	**ADVANCEDCLINICALBIOCHEMISTRY**
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	The learning objective of course are : To create an understand in gregarding Blood, its function, neurotransmitters, neurohormones, composition function and regulation of body secretions, organ function test and Cancer.
Expected Outcome	The student will be able to conceptualize about ● Blood and its function ● Neurohormones and Neurotransmitter ● Organ function test ● Cancer

Unit-I	**Blood and its function, Synaptic transmission, Neurotransmitters & Neurohormones.**
Blood composition and its function Blood-Pressure, Mechanismandregulationofbloodcoagulation.thalassemia.haemorrhagic disorder–haemophilia,purpura,porphyries,circulatinganticoagulants.sicklecellanemia, Synaptictransmission,NeurotransmittersandNeurohormones,Biochemistryof vision.	
Unit-II	**Composition function and regulation of bodysecretions**
Composition,function sand regulation of saliva,gastric,pancreatic,intestinalandbilesecretions.Digestionandabsorptionof carbohydrates,lipids,protein sand nucleicacids. Structure of Nephron, Composition and formation of urine. Clinical significanceofurinarycomponents.homeostatic regulationof waterandelectrolytes.Acid-Basebalance,-AcidosisandAlkalosis. Compositionandbiochemicalanalysis ofCSFandamniotic fluid.	
Unit-III	**Organ function test**
Liverfunctiontestandrelateddisorder:Jaundice, hepatitis,fattyliverand gall stone, Cirrhosis. Renalfunctiontestandrelateddisorders, Gastricandpancreaticfunctiontest. Diagnostictestforlipoproteinsdisorders.Obesity–Definition,Geneticandenvironmentalfactorsleadingto obesity	
Unit-IV	**Enzyme: Clinical significance in health and diseases**
Clinicalsignificanceofenzymesin healthanddiseases.biochemicaldiagnosisofdiseasesbyenzymeassays.SGOT, SGPT, CPK, alkalinephosphatase, cholinesteraseand LDH.Inbornerrorsofmetabolism:diabetesmellitus,gaucher'sdisease,taysach'sdisease,Niemannpickdisease,phenylketonuria,alkaptonuria, albinism,maplesyrupdisease,. SexualTransmittedDisease	
Unit-V	**Oncology**
Oncology–CancermarkersfororalCancer,Breastcancerand gastrointestinaltractcancer.Alphafetoproteins,Carcinoembryonicantigens,Leukemia.Freeradicalsindiseases-Introduction,Typesoffree radicals,freeradicalinducedlipid peroxidation.Scavengers–Superoxidedismutase,catalase,peroxidaseandantioxidants	
Reference books	1.ClinicalBiochemistry:AnIllustratedColourText,4ebyAllanGaw,MichaelJ. Murphy(2008) 2.Marks'BasicMedicalBiochemistry:AClinicalApproachbyMichaelA.LiebermanandAllanMarks(2008) 3.TextbookofBiochemistrywithClinicalCorrelationsbyThomasM.Devlin.(2010) 4.ClinicalChemistry:Techniques,Principles,CorrelationsbyMichaelL.Bishop,EdwardP.Fodyand Larry E.Schoeff(2009) 5.ClinicalBiochemistry(Fundamentalsof BiomedicalScience)byNessarAhmed(2011) 6.EssentialsofMedicalBiochemistry:WithClinicalCasesbyN.V. BhagavanandChung-EunHa(2011) 7.MedicalBiochemistryataGlancebyJ. G.Salway(2012)
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC636	**Antivirals and Vaccine Development**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of basic microbiology.
Learning objective	The learning objective of course are: To create an understanding regarding the virology.
Salient features	The student will be able to conceptualize basics of virology
Unit-I	**Conventional vaccines** **5 hours**
	Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA

	vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues.
Unit-II	**Animal models** **4 hours**
	Animal models and vaccine potency testing.
Unit-III	**Immune markers** **5 hours**
	Vaccine induced immune response and immune markers of protection
Unit-IV	**Designing and screening for antivirals** **5 hours**
	Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance.
Unit-V	**Drug designing** **5 hours**
	Anti-sense RNA, siRNA, miRNA, ribozymes, in silico approaches for drug designing.
Reference books	1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker. 2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated. 3. Chimeric Virus -like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc. 4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC644	**Viral Disease and Cancer**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of virology.
Learning objective	The learning objective of course are: To create an understanding regarding the Oncogenic viruses and pathogenesis of cancer.
Salient features	The student will be able to conceptualize basics to advance of croos talk between virology and oncology.
Utility	A degree in Biotechnology allows students to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and plants.
Unit-I	**Basics of clinical virology** **7 hours**

	Normal microbiota of human body; Role of resident flora and human host; Routes of transmission of pathogens; Nosocomial infections; Collection, transportation and processing of clinical samples; Isolation and identification of pathogenic organisms; Quality control in medical microbiology laboratory
Unit-II	**Viral respiratory diseases 7 hours**
	Origin and evolution of viral respiratory diseases. History, clinical features, epidemiology, of influenza, RSV and other respiratory diseases. Biology of respiratory viruses. Biology and pathogenesis of SARS, Metapneumovirus, human rhino virus and Corona virus etc. Diagnostics Differential diagnosis of different respiratory diseases.
Unit-III	**Clinical Infections-Haemorrhagic Fever 7 hours**
	Common clinical features of Viral Haemorrhagic Fevers, History and Disease burden, Risk factors and geographical distribution of viruses associated with haemorrhagic fevers and their impact on global health. Haemorrhagic manifestations caused by other viruses Virus replication strategy, Pathogenesis, Prevention and treatment of Yellow Fever, Chikungunya, Ebola, and Rickettsial fevers. KFD and Development of killed KFD vaccine.
Unit-IV	**Clinical Infections-II 7 hours**
	Rubella, CRS, mumps and Poxviruses. Clinical features, disease burden of Rubella, CRS and mumps,case definition and risk factors. Preventive and therapeutic modalities. Pathogenesis of disease. .Clinical aspects of Parvovirus. Pox diseases Common features of viral pox diseases and case definitions. Para-specific immunity due to pox vaccination, eradication and control programs.
Unit-V	**Enteroviral Diseases and Cancer 8 hours**
	Rotavirus diversity, emerging strains, immunopathogenesis and vaccines under development. Other viruses associated with diarrhoea and gastroenteritis: Adenoviruses. Polio & Non-polio Enteroviruses. Viral oncogenesis, oncogenic viruses HPV, HTLV, Epstein Barr virus
Reference books	1. Fields Virology, Volume 2, 4th edition:(2001). 2. Clinical Virology, Second Edition (Richmans Hayden). 3. Hepatitis Viruses (Japan medical research fourm). 4. Viral Hepatitis and Liver disease, A.J. Zuckerman. 5. Viral Infection of Humans (S. Svans& A Kaslow). 6. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC646	**Fermentation Technology**
Version	III
Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.

Learning 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 biotechnology industry. .
Expected Outcome	The student will be able to conceptualize about Appreciate relevance of microorganisms from industrial context;• Carry out stoichiometric calculations and specify models of their growth; • Give an account of design and operations of various fermenters;• Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products; • Calculate yield and production rates in a biological production process, and also interpret data; • Calculate the need for oxygen and oxygen transfer; • Critically analyze any bioprocess from market point of view; • Give an account of important microbial/enzymatic industrial processes in food and fuel industry.
Unit-I	**Basic principle 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.	
Unit-II	**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.	
Unit-III	**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.	
Unit-IV	**Application 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.	
Unit-V	**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	
Reference books	1. Shuler, M. L., &Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts.* Upper Saddle River, NJ: Prentice Hall. 2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press. 3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker. 4. Bailey, J. E., &Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill. 5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC616	Food and dairy Microbiology
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Microbiology basic principles.
Learning objective	The learning objective of course are:To create an understanding regarding the life science, To gain knowledge about industrial food fermentations, Quality assurances in foods, foods preservation methods, fermentation of milk products and beverages and Advanced Food Microbiology.
Expected Outcome	The student will be able to conceptualize about ● Fermented vegetables, fermented Meat, Bakers Yeas ● Methods of food preservation ● Fermented milk product ● Applications of micro bialenzymes in dairy industry
Unit-I	**Industrial Food fermentations**
Starterculturestheirbiochemicalactivities,productionandpreservationofthe followingfermentedfoods. a.Soysauce fermentationbyMoulds b.Fermentedvegetables–Saurkrautc.Fer mentedMeat–Sausages d.ProductionandapplicationofBakersYeast e.Applicationofmicrobialenzymesin foodindustry	
Unit-II	**QualityAssurancesinfoods**
Foodborne infectionsand intoxications; bacterial with examples of infective and toxic types –,Clostridium,Salmonella, Shigella,Staphylococcus,Campylobacter,Listeria.Mycotoxinsinfood withreferenceto Aspergillusspecies. Quality assurance: Microbiological quality standards of food. Government regulatorypracticesandpolicies.FDA,EPA, HACCP,ISI.	
Unit-III	**FoodPreservationmethods**
Radiations-UV,Gammaandmicrowave,Temperature Chemicaland naturallyoccurringantimicrobials.Biosensorsinfoodindustry.	
Unit-IV	**FermentationofMilkproductsandBeverages**
Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilusmilk,yoghurt). Roleofmicroorganismsinbeverages–teaandcoffeefermentations.VinegarFermentation	
Unit-V	**AdvancedFoodMicrobiology**
Genetically modified foods. Biosensorsin food,Applicationsof microbialenzymesin dairyindustry[Protease,Lipases]. Utilizationanddisposalofdairyby-product–whey	
Reference books	1.FoodMicrobiology.2ndEditionByAdams 2.BasicFoodMicrobiologybyBanwartGeorgeJ. 3.FoodMicrobiology:FundamentalsandFrontiersbyDolle 4.Biotechnology:FoodFermentationMicrobiology,Biochemistryand Technology.Volume2byJoshi. 5.FundamentalsofDairyMicrobiologybyPrajapati. 6.EssentialsofFoodMicrobiology.EditedbyJohnGarbult.ArnoldInternationalStudentsEdition. 7.DairyMicrobiologybyRobinson.VolumeII andI.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC 620	GENOMICS AND PROTEOMICS
Version	II
Prerequisite	All students are expected to have a genera knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.
Expected Outcome	The student will be able to conceptualize knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
Unit-I	**Basics of genomics and proteomics**
Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.	
Unit-II	**Genome mapping**
Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.	
Unit-III	**Genome sequencing project**
Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.	
Unit-IV	**Comparative genomics and proteomics**
Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence. Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.	
Unit-V	**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 function- forward and reverse genetics, gene ethics; protein- protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.	
Reference 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. 2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press. 3. Campbell, A. M., &Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC648	**Plant and Animal tissue culture**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Expected Outcome	Helps in understanding the combination of biotechnology and nanotechnology and various technologies used for Nanotechnology research.
UNIT-I	**Animal Cell and Tissue Culture** **08 hours**
Introduction of Animal Cell and Tissue Culture, History of development of Animal cell culture techniques, Significance and Applications of tissue culture techniques.	
UNIT-II	**Requirements in Animal Cell Culture**
Requirements in Animal Cell Culture, Equipments used in Cell culture, Culture vessels, Aseptic techniques, Culture media, designing of culture media, Serum free media development. Cell cycle analysis and	
UNIT –III	**Types of cell culture** **06 hours**
Primary culture, secondary culture, cell line, cryopreservation, contaminations, organotypic culture, Insect Cell Culture: An Overview, In vitro transformation of animal cells, Types of cell culture. Cell culture in vaccine production and drug/therapeutics development.	
UNIT-IV	**cancer studies using cell culture** **07 hours**
Synchronization of cultures, cancer studies using cell culture, production of hybridoma and monoclonal antibody production. Animal cloning, Therapeutic cloning, Tissue engineering, Knock out animals.	
UNIT-V	**plant tissue culture** **07 hours**
Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering. Introduction to animal cell and tissue culture and its applications, production of transgenic animals, cell transformation and cell lines, animal cloning.	
Text Book	*Bionanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation: (Percent Weight-age)	
Recommended by BOS on :	

Adopted by Faculty on:	
Approved by Academic Council on :	

SC626MICROBIALDIVERSITYANDPHYSIOLOGY	**BIOENTREPREUNERSHIP**
SC626MICROBIALDIVERSITYANDPHYSIOLOGY	**Bio Entrepreneurship**
Version	III
Prerequisite	All students are expected to have a general knowledge of Microbiology.
Learning objective	Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach studentsabout concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.
Expected Outcome	The student will be able to conceptualize Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.
Unit-I	**Innovation and entrepreneurship in bio-business**
Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.*pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunitiesfor innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	
Unit-II	**Bio markets - business strategy and marketing**
Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	
Unit-III	**Finance and accounting**
Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	
Unit-IV	**Technology management**
Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).	

.

Reference books	1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion. 2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 3. Onetti, A., &Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge. 4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press. 5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC650	**MOLECULAR DIAGNOSTICS**
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer. ● .
Expected Outcome	Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
Unit-I	**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.	
Unit-II	**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.	
Unit-III	**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.	
Unit-IV	**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.	
Unit-V	**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.	
Reference books	1. Campbell, A. M., &Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press. 4. Coleman, W. B., &Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical* laboratorian Totowa, NJ: Humana Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOS on:	
Approved by academic council on:	

SC652	**EMERGING TECHNOLOGIES**
Version	II
Prerequisite	All students are expected to have a general knowledge of techniques applicable in biotechnology..
Learning objective	This course is broad-based in nature encompassing several new technologies that current researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.
Expected Outcome	The student will be able to conceptualize about: Theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.
Unit-I	**Optical microscopy method**
Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, signal-to- noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Stimulated Emission Depletion (STED).	
Unit-II	**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.	
Unit-III	**Systems biology**
High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.	
Unit-IV	**Structural biology AND CRISPR –CAS**

X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small- angle X-ray scattering, Atomic force microscopy. 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.

Unit-V	**Nanobodies**
Introduction to nanobodies, 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.	
Reference books	1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., &Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev, J., & Theriot, J. (2009). P*hysical Biology of the Cell*. New York: Garland Science. 4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). *Biological Physics: Energy, Information, Life*. New York: W.H. Freeman. 5. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev. biochem.77.061906.092014. 6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems.* Science, 353(6299). doi:10.1126/science.aad5147. 7. Lander, E. (2016). *The Heroes of CRISPR.* Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041. 6. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612),

342-344. doi:10.1038/535342a.

7. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). *A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity*. Science, 337(6096), 816-821. doi:10.1126/science.1225829.

10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers,

C., Songa, E. B., Hammers, R. (1993). *Naturally Occurring Antibodies Devoid of Light*

Chains. Nature, 363(6428), 446-448. doi:10.1038/363446a0.11. Sidhu, S. S., & Koide, S. (2007). *Phage Display for Engineering and Analyzing*

Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487.

doi:10.1016/j.sbi.2007.08.007.12. Steyaert, J., &Kobilka, B. K. (2011). *Nanobody Stabilization of G Protein-Coupled*

Receptor Conformational States. Current Opinion in Structural Biology,

21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.13. Vincke, C., &Muyldermans, S. (2012). *Introduction to Heavy Chain Antibodies and*

Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-

968-6_2.14. Verheesen, P., &Laeremans, T. (2012). *Selection by Phage Display of Single*

Domain Antibodies Specific to Antigens in their Native Conformation. Single

Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). *Molecular Imprint*

of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol.

Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni,

M. (2013). *Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody.*

Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.17. Chakravarty, R., Goel, S., & Cai, W. (2014). *Nanobody: The "Magic Bullet" for*

Molecular Imaging? Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT

Recommended By BOS on:	
Approved by academic council on:	